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9 March, 1892

ANNUAL REPORT

OF THE



CHIEF OF ENGINEERS,

UNITED STATES ARMY,

TO THE

SECRETARY OF WAR,

FOR

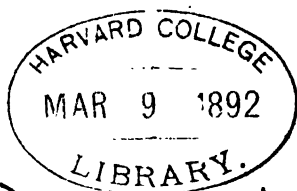
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Chief of Engineers

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TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

(CONTINUED.)

APPENDIXES
TO THE
REPORT OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY.
(CONTINUED.)

APPENDIX

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*REPORT OF CAPTAIN J. H. WILLARD, CO
IN CHARGE, FOR THE FISCAL YEAR END
DOCUMENTS RELATING TO THE WORKS*

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UNITED STATES
VI

GENERAL: I have the honor to transmit
works of river improvement in my charge
June 30, 1891.

Very respectfully, your obedient se

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

V I.

IMPROVEMENT OF RED RIVER, LOUISIANA AND ARKANSAS.

Red River rises in northern Texas, in the *Llano Estacado*, and flows in a general easterly direction, forming the boundary between Indian Territory and Texas. At Fulton, Ark., its course changes to a general southeasterly direction, and after crossing the State of Louisiana it enters the Mississippi River at Red River Landing. The river is about 1,200 miles long; the part included in the project under this head of improvement extends from Fulton, Ark., to the mouth of Atchafalaya River, about 525 miles.

Work was begun by the United States as early as 1828, and appropriations aggregating \$535,765.50 were made at intervals between 1828 and 1852. Between 1841 and 1852 no appropriation was made, and a longer period elapsed between 1852 and 1872, during which the results of former work were lost.

The present improvement commenced in 1872. The project contemplated the removal of rafts, snags, wrecks, leaning timber, etc., closing Tones Bayou, and other outlets; opening a channel through the falls at Alexandria, La., and deepening the channel at sand bars; to improve and keep navigation open from Fulton, Ark., to the mouth of the Atchafalaya; also protection of caving banks at Alexandria.

The appropriations have been as follows:

Act of June 10, 1872—	
For improving Tones Bayou.....	\$20,000
For removing raft.....	150,000
Act of—	
March 3, 1873, for removing raft.....	80,000
June 23, 1874, for removing raft.....	50,000
March 3, 1875, for removing raft.....	20,000
August 14, 1876, for removing raft and closing Tones Bayou.....	35,000
Allotment of August 27, 1877, from the appropriation for repair, preservation, etc., of river and harbor works, act of April 10, 1869, for closing Tones Bayou.....	4,500
Act of February 7, 1878, for removing raft, etc.....	6,000
Act of June 18, 1878—	
For removing raft and closing Tones Bayou.....	24,000
For removing snags, etc.....	25,000
Act of March 3, 1879—	
For removing raft and closing Tones Bayou.....	15,000
For removing obstructions.....	22,500
For improving river above head of raft to Fulton, Ark.....	10,000
Act of June 14, 1880—	
For removing raft and closing Tones Bayou.....	25,000
For removing obstructions.....	60,000
For improving river above head of raft to Fulton, Ark.....	10,000
Act of March 3, 1881—	
For removing raft and closing Tones Bayou.....	10,000
For removing obstructions.....	10,000
Act of—	
August 2, 1882, for improving Red River.....	75,000
July 5, 1884, for improving Red River.....	75,000
August 5, 1886, for improving Red River, making survey of same, and completing survey of Bayou Pierre, Louisiana.....	75,000
Act of August 11, 1888—	
For improving Red River, Cypress Bayou, and Bayou Dorcheat.....	65,000
For survey of Red River.....	35,000
Act of September 19, 1890—	
For improving Red River.....	100,000
For survey of Red River.....	28,000
Aggregate of appropriations 1872 to 1891.....	1,030,000

The amount expended to June 30, 1890, was \$888,783.69, resulting in great benefit to navigation. A channel was opened through the great raft in 1873, and operations since, aided by the action of the current, have secured an enlarged channel way with greater depth everywhere, continually widening and scouring, and but little water is diverted from the river proper at ordinary stages. The work of removing obstructions, clearing the banks, and the prompt removal of all jams and keeping the drift in motion during high stages have prevented any new formations of raft. Several attempts have been made to close Tones Bayou, but no work has been done at this outlet since 1882, when the dam under construction was destroyed. The bayou is filling up gradually with drift, and this, in connection with the work in the old raft region above, is causing "Little River" (below the mouth of the bayou to Grand Ecore) to widen and scour, the effect having been specially noticeable the past two years. The rock excavation and dam at the Falls of Alexandria were completed in 1885, increasing the period of navigation about 2 months, and as a general thing permitting boats to pass the falls the year round, though passage is somewhat difficult at extreme low stages on account of the deflection at the middle of the cut. The dam and training wall for protecting the caving bank at Alexandria, built in 1884-'85, accomplished the purpose for which intended, and it is plain that the banks no longer cave within their influence, but a repetition of the work is desired at an interval of 200 or 300 feet below, where there has been slight erosion. The removal of snags and clearing the banks for the general improvement of the river were not begun until 1878, all former appropriations having been for removing raft and closing Tones Bayou, but since 1885 operations have been confined to that class of work, as it was deemed advisable to defer other projects until the survey should be finished.

An annual appropriation for the removal of snags and other obstructions will be required for many years. In the old raft region, both above and below Shreveport, sunken logs are scouring loose continually and are a constant source of danger to low-water navigation. Others thoroughly water-logged form bars, impassable at low stages. For hundreds of miles the banks of the upper river are covered with a heavy growth of timber, which is caving and sliding into the river continually, and during high stages the amount of drift is enormous. In the old raft region above Shreveport jams form in a few hours, sometimes acres in extent, and require prompt removal before the water falls. Caving banks leave dangerous shore snags projecting far out into the river, which should be cut after every rise and fall.

Operations during the fiscal year ending June 30, 1891, were as follows:

GENERAL IMPROVEMENT.

During July and the early part of August the United States snag-boat *C. W. Howell* was repaired, so far as necessary to enable it to resume work, and fitted up with temporary wooden shears to be used with the capstan, and the boat in command of M. B. Lydon left Shreveport August 11, to work in the river below. August 17 word was brought to the *Howell* that the steamer *New Haven* had grounded at Pickett Bend, about 3 miles below, and if assistance was not obtained the boat would break in two. The *Howell* started for the disabled steamer, and on the way down struck a snag, knocking a hole in her bottom about 12 feet long by 3 inches wide. The leak was stopped with mattresses and blankets and a bulkhead built around the break and filled

with mud, after which, August 18, the stranded steamer, which almost bridged the river, was pulled off. The *Howell* continued snagging upstream, and reached Shreveport August 26. On the way up brush dams were built at Chalk Level Bar $5\frac{1}{2}$ miles below Shreveport, which caused the channel to scour to a depth of 4 feet (an increase of $2\frac{1}{2}$ feet), the *Howell* drawing 3 feet passing over with ease.

From August 27 to September 8 a minimum crew was retained on the *Howell* and employed in repairing the hole in the bottom. A small sectional dock with cushioned edges was made and sunk around the leak, the water was pumped out, and a new sheet riveted over the break. Much credit is due to the master of the vessel for the rapid, economical, and efficient manner in which the damage was repaired.

From September 9 to October 10 the *Howell* was employed in the "Little River" below Tone's Bayou, removing all snags in sight and all snags and logs that could be caught with the sweep or drag chain. The same stretch may be gone over again and about as many obstructions will be found, as the bottom logs are in nests and wrack heaps, and after waiting a period sufficient for the bottom to scour they can be dislodged with the drag chain and removed. On completion of this work the *Howell* was sent to the mouth of Atchafalaya to work back, the lower part of the river having been reported badly obstructed by tree slides, wrack heaps, and mud lumps, especially in the stretch known as the Rapions. Work in the lower river was continued until November 19. From that date until November 24 the crew assisted in repairing the two quarter boats belonging to this improvement laid up with the Commission fleet at Simmesport, La., and November 24-29 the *Howell* was on the way to Shreveport with these boats in tow. The *Howell* remained at Shreveport, undergoing some minor repairs, until December 5, and on that date a trip of inspection was made by Col. C. B. Comstock, Corps of Engineers, Division Engineer, myself, and Assistant Engineer Marshall, from Shreveport to Knox Point and return. December 8 and 9 the snag boat *Breck* was towed back to Shreveport by the *Howell*, the water having risen too much for it to continue work. December 11 the *Howell* left Shreveport for Alexandria, and reached the latter place December 13, having done such work as was found necessary on the way down. The boat remained at Alexandria until the adjournment of the Board of Officers convened to consider the plan and location of the proposed bridge across Red River near that place, and was used by the Board in visiting the proposed site of the bridge and in making trial trips through the selected position for the draw span. After the Board adjourned, the *Howell* returned to Shreveport, doing some work on the way up, and arrived at that place December 20. On December 26 the *Howell* took the *Breck* in tow, for work in the river above Shreveport. The *Breck* was dropped at Rush Point the following day, and the *Howell* continued operations up to Fulton, Ark., the upper limit of this improvement, which was reached the morning of January 14, and from this date until March 1 the boat was employed on the work of improving Red River above Fulton. During March and April the stages were too high for effective work, and the boat remained at Shreveport, undergoing such repairs as were needed.

A heavy rise set in the latter part of April, with a large amount of drift running, and the *Howell* was ordered out by telegraph to break and prevent jams. Three days were spent at the Shreveport Bridge clearing jams and waiting for the heaviest drift to pass or stop running (the latter event would have shown that the drift had jammed above), and April 30 the boat passed above the bridge and continued upstream,

removing snags, jams, side jams, etc., and reached the "Head of Raft," 65 miles above Shreveport, May 8. By that time the river had commenced to fall, and as there was little drift running the boat started back. Large quantities of drift were overtaken on the way down, dispersed, and kept in motion. The *Howell* reached Shreveport May 10, and May 11 and 12 patrolled the river up to the mouth of Cottonwood Bayou, then returned and was laid up.

June 4-11 the *Howell* patrolled the lower river from Shreveport to the mouth, removing all obstructions found in the way, and on June 12 the boat entered Black River and was employed in that stream and the Ouachita until the end of the year. A large and dangerous snag at the mouth of Red River, which had been complained of by the river men, was removed June 11, at the request of First Lieutenant Millis, Corps of Engineers. This snag was over 100 feet long and imbedded 15 feet in the mud, and required 6 hours' work to remove it. Two steam tugs had worked at it simultaneously but without any effect.

The work of the *Howell* during the fiscal year is summarized as follows:

Snags pulled.....	1,067
Stumps pulled.....	83
Logs removed from channel.....	4,868
Jams removed.....	8
Side jams removed.....	121
Shore snags cut.....	874
Leaning trees cut.....	674
Wrecks removed.....	2
Points of land removed with explosives, near Long Branch, Louisiana.....	3
Linear feet of brush dams built.....	350

September 19 and 20 I made a personal inspection on the *Howell* of the river from Shreveport to Knox Point, 40½ miles below, and upon my return to Shreveport directed that the small hand-propelled snag boat *Harry Breck* be fitted out for shore work in the Little River. This was done and the boat was towed down by the *Howell* September 21-22.

The *Breck* commenced operations just below Scopini Cut-off September 23. The work consisted of cutting stumps, shore snags, leaning timber, brush, etc., thoroughly clearing both banks for from 20 to 30 feet back from the river, and was carried down stream to Pascagoula, La., a distance of 17 miles, where it was suspended December 9 on account of high water, and the boat was towed back to Shreveport the same day.

December 10 repairs of the *Breck* were commenced; the decks were renewed, calked, and strengthened, machinery repaired, new guys for the shears put up, and the boat overhauled and put in good condition to resume work. December 26-27 it was towed by the *Howell* to Rush Point, 33½ miles above Shreveport, where operations were resumed. Shore work was carried down stream to Fire Point, 11½ miles below, where it was suspended February 5, and the boat transferred to the improvement of Red River above Fulton. After suspension of operations on that work the *Breck* was laid up at Fulton to await a stage low enough to resume work to advantage. On May 12 it left Fulton and was dropped down to Alban Canal No. 2, 126½ miles below Fulton and 61½ above Shreveport, where bank work was commenced May 19, and was continued down stream until the end of the fiscal year. On

*Steamer *Richmond*, at Devil's Elbow, 10½ miles below Shreveport (sunk 1868), and stern of steamer *Era No 13*, at Lovely Point, 43 miles below Shreveport (sunk 1873).

the 30th of June the boat had reached Posten Bayou, 53 miles above Shreveport. Progress was slow, as the banks were overgrown with brush and vines, and all trees were cut into short lengths so as not to become channel obstructions in the future. Operations with the *Breck* during the year were conducted under the immediate supervision of Overseer W. W. Moore, who reported the following summary of work done:

Snags and trees removed from channel.....	30
Shore snags removed.....	1,582
Side jams removed.....	4
Leaning trees removed.....	9,348
Trees girdled.....	1,138
Stumps removed.....	2,564
Square yards brush and willows cut.....	109,200
False points removed with explosives.....	2

The removal of obstructions during the past year has been of great benefit to navigation, as is evidenced by the fact that not a vessel was lost, and, to my knowledge, there has been no serious accident. The New Orleans and Shreveport boats ran through the Little River on regular time with the gauge at Shreveport reading only 2 feet, a condition previously unknown by any of the pilots whom I questioned.

The plant when not in use was laid up at Shreveport, and cared for properly to prevent deterioration. The rented storehouse upon the bank near the boats was destroyed by fire September 6. The fire broke out upon the opposite side of the street, but spread quickly. Every effort was made by the employes to save the property, but as the wind was blowing toward the fleet, they had all they could do to save the boats. With the exception of skiffs, the greater portion of the property destroyed was of little value, and had been moved from the boats where it was needed no longer.

ALEXANDRIA.

The act of September 19, 1890, provided that "\$15,000 shall be used in the work at Alexandria." No portion of this amount has been expended, but it is intended to enlarge the channel through the upper falls by dredging, depositing the excavated material on the east shore end of Baileys Dam at the lower falls, and buying more for that purpose if necessary. Soundings were made in August during the progress of the survey of Red River for a working map in case an allotment should be made for protecting the bank at Alexandria, but no work was done on account of the lateness of the appropriation and the continued high water to the close of the fiscal year. It is advisable to put this work off as long as possible, because it is a very delicate matter to decide upon a work for bank protection other than revetment that shall form part of an intelligent plan for the permanent improvement of the stream. Property owners along shore below the bridge at Monroe, on Ouachita River, have protected the river front at their own charges by an arrangement of piles and planks set in terraces, and it is desired to observe the effect of this comparatively inexpensive work. Revetment with mattress work or stone alone, as used with success on the Mississippi, is to be preferred to any other kind as shore protection, but the property owners at Alexandria are unwilling to give any part of the bank outside the town levee to be graded away, which would have to be done if revetment were adopted, to give any easy slope and prevent its sliding into the river. But if the recent decision of the United States court may be followed, in which it was held that the State commission-

ers of Louisiana may build levees for common protection upon private property without condemnation and purchase, the banks of Red River may perhaps be taken in the same way, and graded and revetted to protect the levees along the river; and under the same decision levees may be rebuilt, to confine the flood waters for improving navigation, while protecting the people from overflow.

Piling can not be used at Alexandria on account of the rock underlying the bottom, and the objection to crib work is that it ought to be carried up to high water to prevent boats running into it, and, as the line to be protected is used for steamboat landings, the danger would be greater in time of flood.

The channel work at the bridge site above can be done at medium stages, but it will be better to wait for an extreme low stage when the water is clear. Work can then be prosecuted without the help of divers and the progress can be seen. With two dump scows for general service in the district the work could be done most economically with hired labor and the plant now on hand, and the most suitable time chosen, without the delay necessary for making a contract; and, besides, there would be no charges for demurrage in case the work should be stopped by a sudden rise. The estimate for two dump scows is \$3,500, and for two months' work of the dredge, steamer, explosives, and materials, \$5,000.

It may be noted here that a considerable study of Red River indicates the possibility of dividing it in two at the falls, and making a partial slack-water system above Alexandria by a combination of fixed and movable dams, with a lock of size needed by the largest boats that can reach Alexandria at low water. This is to be considered only as a suggestion, and in the line of the recommendation made by Major Howell about 17 years ago. The subject will have to await the completion of the general survey now going on.

LITTLE RIVER, FROM THE SCOPINI CUT-OFF TO KNOX POINT.

An allotment of \$20,000, to be expended in "widening and deepening" this part of Red River, a stretch $21\frac{1}{2}$ miles long, below Tones Bayou, was made by the act of September 19, 1890. The terms of the act would seem to indicate that some form of construction work should be adopted in this reach, or that dredging should be undertaken, neither of which is advisable at present, and the latter unnecessary and inexpedient.

To widen and deepen the river at the same time can be done, but the result would prove disastrous to the stream in a short time. Dredging would be difficult and expensive, owing to the mass of logs which fills the bottom, and to widen the river would reduce its depth, now sufficient for present river traffic.

The survey of this stretch has been gone over, and it is found to be widening too rapidly. What is most needed is to remove false points to make the bends easier, and to begin a substantial revetment of the caving banks to prevent further encroachment and secure the levees, put in by the State at great cost to the people, and which serve to improve the navigation of the river while protecting them from overflow.

The best form of work in the channel will be to send the snag boats over the reach at intervals, to pull up the channel snags and logs as they become loosened by the work of the current itself. Far better results can be got in this way than by keeping boats constantly at work over the same ground. When the survey is put into shape for study measurements can be taken and estimates prepared for such re-

vetment work as shall be judged of first importance. In the mean time the allotment will be expended only when work can be done in the channel to best advantage. This is peculiarly a case where good results from judicious waiting.

SHREVEPORT HARBOR.

Since the removal of the raft by which the volume down the main river has been increased, the left bank opposite Shreveport has gradually receded, while a wide batture has formed along the city front. If measures are not taken soon to check this, the harbor of Shreveport will be seriously impaired, and the cost of restoring it and keeping navigation reasonably good to the river above will be much increased. The whole of the opposite bank should be revetted for a distance of at least 2,500 feet, for if the bank should cave back to the higher ground on which the levees run, it would be practically impossible to confine the flood waters to the main river, but they would escape into the low ground beyond the left bank, and not return to the river until they had filled up the country below and found their way into Lake Bistenau and Loggy Bayou. This would mean disaster to Shreveport and to the planters of Bossier Parish, and probably destruction of navigation from Loggy Bayou upstream.

The rise and fall of the river at Shreveport is about 11 metres, or say 35 feet, and the bank line needing revetment begins some 2,200 feet above the railway bridge, and includes a pocket below of about 300 feet; making in all 2,500 feet, more or less, to be graded and protected. The grading can be done with pumps used for washing snags, and if the work is done at low water the mattresses can be built of stone, put in without the use of special plant. Taking a slope of 1 on 3, the protection would average about 100 feet in width, and the cost, including contingencies, should not exceed \$16 the running foot, or say \$40,000 for the whole. Under favorable conditions it is probable that the cost can be reduced, but as stone must be brought either by rail or river from a considerable distance, it is not thought safe to reduce the estimate.

CLOSING THE SALE AND MURPHY OUTLET.

When the river above Shreveport was closed by the great raft there were numerous lakes along both sides connected with the navigable parts of the main river by bayous or outlets, some of which were natural and others artificial, and these lakes and outlets were used at high stages for passage of boats to the head of the raft. As the different rafts formed upstream the lower outlets were abandoned for newer ones above, and if the latter were not of sufficient capacity they were cleaned out and enlarged, or else short canals were dug at convenient points to form the connections between the river and lake channels. Such were Alban Canals Nos. 1, 2, and 3 on the left, and Hervey, Kountz, and Sale and Murphy on the right bank, on which heavy tolls were exacted. The removal of the raft opened the main channel of the river and the outlets fell into disuse, and have gradually filled up with deposit and drift until but little water is drawn from the main stream except at high stages. Their closure will tend to enlarge the river channel and will protect adjacent lands against overflow.

The Sale and Murphy Canal is the uppermost of these outlets, 66½ miles above Shreveport and 3 miles below the Arkansas and Louisiana line. In 1882 estimates were made for closing all these outlets by dams of brush and stone, with mattress protection on bottom and sides, to

resist the scour, and the cost of closing Sale and Murphy was given at \$6,900. (Report Chief of Engineers 1882, pages 1546-1547.) By the act of July 5, 1884, \$5,000 was allotted to close this outlet, and as this amount was not sufficient to carry out the original project, it was decided to build the dam of brush mattresses and earth. The dam was built in November, 1884, but before it had time to solidify the December flood came and it was destroyed. No work has been done for the closure of the outlet since.

The act of September 19, 1890, directed that \$5,000 of the appropriation should be applied to closing this outlet. In November Assistant Engineer John Ewens was sent to make an examination for the purpose of preparing plans for the work required. His report is given below:

I left Vicksburg November 6, but owing to a change in time of steamboats was unable to leave Shreveport until November 8, at 10 a. m., and arrived at the Sale and Murphy Canal the morning of November 9. I found the canal for a distance of 100 feet from its mouth back completely covered with an immense jam of drift logs and trees, very few of which were not of formidable proportions. Around the base of this conglomeration of debris a heavy deposit of sand and clay has formed, making an impassable barrier, which is closing the canal gradually through the natural action of the river, and, judging from the present rate of progress, the closure will be complete in 3 or 4 years. After a careful inspection of the canal from its mouth to a point where it divides into several small branches a very desirable section about 1,200 feet from the mouth was selected as the one most suitable for an embankment to close the outlet. The favorable features it presents are as follows:

1. A foundation free from stumps, logs, etc., that always prove fatal to levee embankment.

2. It is the narrowest section between high banks; has the minimum water section at a stage at which the closure will have to be made; and a marked bar formation is manifest, greatly reducing the fill and giving a stronger foundation.

3. The banks practically are as high as at the mouth.

4. The best and most accessible material in the vicinity is quite near.

In addition to these salient points, the advantage to be derived from the protection of the immense barrier of drift and deposit will afford can not be estimated too highly. The position selected is as near the mouth as practicable, the governing conditions being to obtain a section that will be free from logs, and at a point where the pressure of inflowing water will be at a minimum. The section was sounded carefully with a pole and distances measured with steel tape. The total width of section from top of high bank is 169.7 feet; the water width at present stage 97.5 feet. For a space of 41 feet an average depth of 8 feet of water was found, but in the spaces on each side of this pool the depth varied from 0 to 6 feet. The highest mark of 1890 (the highest known) was found to be 18.5 feet above the water surface November 9. (H. W. 1890, 232.15 feet Cairo datum.)

The following embankment is recommended for the closure of this outlet: A levee having a crown of 10 feet, to extend 2 feet above high-water mark. Outside and inside slopes 4 on 1. The upper end of the dam to be extended out to the main levee a distance of about 1,500 feet, and the lower end to be extended to edge of swamp, about 1,400 feet. The crown and slopes to be sodded and covered with a thin layer of willows or other brush at hand, laid so as to form a light mattress to be held in place by sacks of earth. On the river face this mattress should be extended at least 100 feet beyond the base of the levee. A structure of this character, properly built, would stand all the pressure it would be subjected to; but in order to have the views of the people who reside in the vicinity of the canal, and who are familiar with the action of the river at all stages and its effect at the canal, I invited Mr. M. Hunt and Mr. T. J. Martin to go over the ground with me and discuss the merits of different locations as possible sites for the dam, and both agreed that the site selected was the most desirable for permanence and economy in building. The magnitude of the drift deposit makes it not only impracticable but very undesirable to adopt any site nearer the mouth.

Estimates.

138 cubic yards main embankment, at 20 cents	\$2, 559. 60
138 cubic yards embankment for extension, at 10 cents	1, 238. 80
Brushing main embankment	250. 00
Protection	300. 00
Contingencies, protecting work during high water, etc	651. 60
Total	5, 000. 00

The 20 cent basis was used, as local parties assured me that they would guarantee to do the work satisfactorily for that price. The 10 cent estimate for extensions on shore I consider large enough, as they can be made with scrapers and very easily. The shore work is important for protection at high water, as the local levee extends to the hills and no water could reach the embankment from above.

Owing to the late period when the appropriation was made it was thought best to defer the work of constructing this dam and the approaches until after the winter and spring floods had passed, in order to give plenty of time for it to consolidate; and for this reason and on account of successive floods and continued high water to date nothing was done to the end of the fiscal year. It is expected to commence the construction by the middle of August, and under ordinary conditions it should be finished within a month or 6 weeks at most.

This work should be regarded only as a beginning, and all of the outlets which now deplete the main river at all stages should be closed gradually, sufficient intervals being allowed to give the channel opportunity to adapt itself to the increased discharge.

SURVEY OF RED RIVER FROM FULTON, ARKANSAS, TO ATCHAFALAYA RIVER.

PROGRESS REPORT.

On account of the difficulty in securing skilled men for the grade of work required on the survey, and the late date on which the appropriation became available after the approval of the project required by law, it was judged most economical to postpone the triangulation and precise levels from Alexandria to the Atchafalaya until the following season. The survey party was reorganized under Assistant Engineer H. M. Marshall, and employed on the survey of Yazoo River from October 29 to December 6, and then transferred to Shreveport and engaged on the survey of the Cypress Bayou and the lakes until April 14, 1891. Upon the completion of the field work the party was divided, one detachment being sent to make additional cross sections of Red River below Shreveport and connect with the stations of former surveys of Little River and Bayou Pierre; and the second detachment was employed in connecting high-water marks with the level lines and measuring the discharge of Red River and outlets above Shreveport.

While the flood of 1890 was rising in Red River persons living along the banks were asked to cooperate with the engineers in fixing the high-water line. About 150 pieces of zinc, lettered H. W. 1890, were mailed to citizens living convenient to the river between Fulton, Ark., and the Atchafalaya, who were asked to nail them to trees or buildings at the extreme height of the flood, and to send descriptions of the locations and dates to this office. About thirty notices were received, and the elevations of the marks have been taken by level wherever the detachment was within reasonable distance of the mark. Other marks have been leveled to after inquiry from persons living along the banks as far downstream as Alexandria. The discharge of eight outlets from the west bank was measured by floats, and that of Twelve Mile Bayou and Cross Bayou taken with the Price current meter, as also the discharge of Red River above and below them. These observations were made on the spring rise, when the Shreveport gauge was 25 feet.

The party was then reduced to a single small detachment—the drafts-men and computers being sent to the office to work upon maps and notes—and engaged in leveling to high-water marks, connecting triangulation stations with gauge sections, and making discharge and sediment observations. The work has progressed satisfactorily, the stage

Photo-Lith. by A. HOEN & CO., Balto., Md.

of river having been high throughout. Observations were taken for 10 days at each of the following stations: On Red River and the outlets and inlets below Shreveport, at Tones Bayou, Loggy Bayou (Lake Bistenau and the Dorcheat), Bayou Wincey (Bayou Pierre), head and foot of Cane River, and at Alexandria. While the discharge measurements were going on simultaneous gauge readings were taken on gauges set at the two consecutive discharge stations, the zeros set by level to the same reference, Cairo datum.

It would be desirable to extend the system of gauges and place them at shorter intervals, and take observations through a long period, so as to get data for determining the slope corresponding to any stage; but the limited appropriation will not permit so great an expenditure. The observations taken will, however, be of great value for stages corresponding to the river heights during progress of this work.

Work in the office has progressed at a good pace. The field sheets of the survey of Upper Red River have been made and the final sheets plotted and inked in outline and the elevations and smaller lettering finished. Eighteen sheets, scale 1 : 10,000, cover the distance from Fulton, Ark., to Shreveport, La., a distance of 301 kilometers (188 miles), of which six are finished except the title, legend, and numbering. Below Shreveport all the field sheets are ready for transfer, and three final sheets have been inked and are ready for the topographical draftsman. This work has been delayed by the draftsman falling ill of typhoid fever, and as it is desirable to have the maps agree in style, the work will not be resumed until he returns to duty.

All the notes from Fulton to Alexandria, about 800 kilometers (500 miles), have been indexed, tabulated, and reduced.

The quarter boats were overhauled and refitted in November and December, in time to be used on the Cypress Bayou survey, and were then occupied by the detachments on Upper and Lower Red River. They are laid up at Alexandria, where the parties will be reorganized in the autumn, after the sickly season, and when the water is low. The decision to postpone the work was a fortunate one, as Red River has been visited by heavy rains since last December, and kept at a stage too high to allow continuous work in the field, and the loss in organizing and breaking up parties at intervals, or in working under great disadvantages, has been avoided.

If the work can be resumed by the middle of September, it is hoped that the line from Alexandria to the Atchafalaya can be covered before Mississippi River rises to block the way by back water, and at least by the end of the year. The country to be surveyed is a very difficult one, and not a little cutting will be found necessary for the lines, and after reaching David Ferry, some 60 kilometers (39 miles) below Alexandria, the precise levels may have to be abandoned or carried around by Avoyelles Prairie to the Mississippi to close on the U. S. Coast Survey bench at Smithland and complete the loop.

To finish the survey on a scale proportional to the importance of the stream will require an appropriation of \$97,000 to be applied as follows:

For 800 kilometers (500 miles) secondary triangulation from Atchafalaya River to Fulton, Ark., at \$75 per kilometer	\$60,000
Borings and transvalley sections at eight stations	8,000
High and low water discharge, sediment observations, and gauges	6,000
Computation and projection of maps	5,000
500 sets maps (100 sheets each) scale 1:100,000	15,000
Repairs and outfit, quarter boats, hire of launch, skiffs, contingencies, and office expenses	3,000
	<hr/> 97,000

An index map of Red River Basin and a sheet giving the limits of high and low water from Fulton to Mississippi River are submitted, which are worthy of attention. The map shows a high-water navigation of over 1,600 kilometers (1,000 miles) exclusive of the Ouachita system of the same amount, and a low-water navigation of 800 kilometers (500 miles) except in extraordinary droughts. The hydrograph shows that under ordinary conditions the slope should be fairly uniform at all stages, but that destructive velocities must prevail at least above medium stages, and that caving banks must be protected to preserve the regimen of the river. The effect of Mississippi floods is shown as far as Black River, the outlet for the Ouachita system, from which alone bad navigation might be predicted in the reach of some 65 kilometers (40 miles) below. In the absence of definite measurements at extreme stages the discharge of both rivers may be assumed to be equal and about 100,000 cubic feet per second in high water, dividing perhaps 200,000 cubic feet per second between the Mississippi and the Atchafalaya, according to the stages at Red River Landing, while at low water the discharge is too small to make a navigable channel into the Mississippi.

With the progress of the survey more definite information will be obtained, and the hydrograph corrected and amended. All the important points should be connected with the common plane, the Cairo datum, and a profile made giving channel depths at low water and the limits above high water for the bottom chords of bridges.

The gauge service should be extended in Red River Valley, and form part of the system of gauges required by joint resolution of February 21, 1871. Those of pressing importance should be established at the railway bridge north of Texarkana, at Coushatta, at or about David Ferry, and the mouth of Black River. The cost of this work is estimated at \$1,500 the first year for gauges, bulletins, and the pay of observers, and \$1,500 for leveling and monuments, and \$1,200 a year thereafter for maintenance, repairs, and inspection.

CYPRESS BAYOU.

As the work between Shreveport and Jefferson, formerly provided for by a special appropriation, was transferred to Red River by an allotment of \$5,000 in the act of August 11, 1888, and as it is advisable to keep this route open through Twelve Mile Bayou, in order to preserve what has been gained by an expenditure of over \$117,000 by the United States and citizens—whether or not the construction of a slack-water navigation shall be found practicable—it is recommended that an appropriation of \$5,000 be made to continue the removal of leaning trees, stumps, and logs, and to mark the route through the lakes by signs or beacons.

Even if boats should not run between Jefferson and Shreveport on regular trips, the knowledge that there is a navigable channel for small boats at medium stages will be sufficient to keep railroad freight charges within reasonable limits, and thus benefit the people for whom Jefferson is the market and distributing point.

GENERAL REMARKS.

The report of last year laid down certain principles for the improvement of Red River, and as no action was taken upon the estimates it is thought important to repeat them, and they are therefore given below with but slight amendments, the suggestion of dividing the river, made under the head of Alexandria, being not inconsistent therewith.

The permanent improvement of Red River offers a problem of exceeding difficulty, the solution of which depends upon certain conditions that exist in no other stream in like degree. The most serious question is the disposition of drift, which runs at times in such quantities as to render navigation hazardous by day and impossible by night. The river is frequently jammed in a few hours with acres of snags and logs; and raft formation is prevented only by prompt service of the snag boats. Should jams occur when funds are exhausted and none expected for some time, it is probable that new rafts would form, diverting the river from the bed in which thousands have been judiciously spent, to lose itself in the lowlands and bayous, destroying by the way a fertile country that has been reclaimed from overflow by the joint work of the improvement and the construction of levees by the State. Should the survey of Red River now in progress to the Atchafalaya indicate that a slack-water system is feasible and for the best interests of navigation, the question of drift would assume larger proportions, possibly even prohibitory. There can be little doubt that it would forbid the general application of any existing system of movable dams; and even with fixed dams the question remains a serious one. Some means would have to be devised to catch drift, keep it out of the channel way and locks, and this would necessitate very long guard walls, with traveling cranes to handle heavy timber. Possibly a combination of two systems might be made, giving a drift pass to be closed by heavy shutters, bear trap, or other device drawn from the best experience on such work.

An open river, however, even with occasional detentions in low water, is to be preferred to any slack-water system with detentions at every lock, if it can be made to give generally a fair navigation throughout the year at a reasonable cost, and its permanency secured by a moderate percentage for maintenance. The importance of the subject can be judged best by referring to the map of the country drained by Red, Ouachita, and tributary streams. Cheap transportation for the entire valley west of Mississippi and south of the Arkansas is possible only through the mouth of Red River to the port of New Orleans and the sea.

Whatever plan shall be adopted for improving the main rivers, or even if the work of giving an assured reasonable navigation in Red River to Shreveport and beyond be delayed for a time, there are certain general principles to be followed, if only to save, till that time comes, what has been gained, or to prevent the river closing. These principles are stated in natural sequence, as follows:

1. The systematic clearing of the banks for some distance back far beyond the limits of this district. It is cheaper to remove the source of drift than to dispose of drift; and the benefit to navigation is immediate.
2. An efficient snag boat service for general work, patrolling the river, preventing jams, removing logs and snags from the channel and banks, and dredging tow-heads and obstinate shoals. Here, again, the benefit is immediate. A permanent appropriation of not less than \$25,000 a year is needed for this purpose.
3. Extending the scope of the survey to embrace the whole valley. This is necessary to the proper study of this river and tributaries, and to furnish all the information required to decide upon a system of improvement and to locate its elements.
4. Construction of a substantial system of levees to restrain the greatest floods, either alone or in partnership with the riparian States.
5. Closing gradually every outlet through which the main streams are depleted at various stages above low water.
6. Fixing caving banks to confine the main stream to the channel selected for it.
7. To exercise a watchful care from first to last to prevent injury to the regimen of the streams by cut-offs or outlets, and to keep the building of bridges within reasonable bounds.

Ordinarily, fixing caving banks should precede levee building and closing outlets, but as the banks are reasonably stable for a considerable part of Red River, and as the object is to get an improved navigation without unnecessary delay, revetment is placed after them. The surest and cheapest way to get the benefit of levees in concentrating the flood waters is to join the States and aid them in restoring and completing their levees. The estimates for levee construction are for completing lines in Louisiana projected by the State engineer. Other lines will be laid down in Louisiana and Arkansas after the survey shall have been completed to the Atchafalaya. The closure of the outlets may be accomplished as part of the levee work when the lines are conveniently near.

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DETAILED ESTIMATES.

Plant.

Flatboat with steam power and crane or shears, cabin, and outfit	\$3,000
Two dump-scows for dredge	3,500
Pile driver with steam hammer and jet	3,500
Small towboat and tender, steel hull	15,000
Skiffs, rigging, tools, etc	2,000

Service of plant.

Expenses of snag and tow boats	25,000
Expenses of dredge	5,000
Expenses of chopping parties	7,000
Excavation of rock and straightening channel at Alexandria	5,000
Removing obstructions in Cypress Bayou	5,000

Care of plant.

Wages, subsistence, and supplies for fleet	3,000
Regular and extraordinary repairs	4,000

Construction.

Repairing and enlarging the State levees by joining with the State engineers and levee boards for the purpose of confining the waters of Red River to the adopted channel, thereby improving and giving ease and safety to the navigation of the river, cubic yards estimated as follows:

Caddo district above Shreveport	50,000
Caddo district below Shreveport	270,000
Bossier district below Shreveport	300,000
Bossier district above Shreveport	30,000
Rapides district, from Alexandria to Avoyelles Prairie	140,000

Total cubic yards, at 20 cents	790,000	\$158,000
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Closing outlets.

Dooley and Red Bayou	4,000
Cottonwood Bayou	7,000
Cowhide Bayou	4,000
Tones Bayou	20,000
Choctaw Bayou	5,000
Draining impounded water from Choctaw Bayou by canal to Bayou des Glaizes, or otherwise	10,000

Gauges.

Establishing gauges and pay of observers	1,500
Leveling and monuments	1,500

Surveys.

Completing survey of Red River according to approved project, including triangulation, transvalley sections, borings, and publication of maps on full scale	97,000
Local surveys and examinations of caving banks for revetment work	3,500

Administration.

Office expenses, stationery, mileage, and contingencies	3,500
Assistant engineers, draftsmen, inspection, and transportation	4,000

Total	400,000
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Money statement.

July 1, 1890, balance unexpended.....	\$13, 236. 33
Amount appropriated by act approved September 19, 1890.....	128, 000. 00
	<hr/>
June 30, 1891, amount expended during fiscal year.....	141, 236. 33
	36, 831. 39
	<hr/>
July 1, 1891, balance unexpended.....	104, 404. 94
July 1, 1891, outstanding liabilities.....	429. 46
	<hr/>
July 1, 1891, balance available.....	103, 975. 48
	<hr/>
{ Amount that can be profitably expended in fiscal year ending June 30, 1893.....	400, 000. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

The amounts expended during the fiscal year ending June 30, 1891, were as follows:

For general improvement, repairs, care of plant, etc.....	\$29, 346. 36
For Cypress Bayou, etc.....	285. 94
For examination and survey of the Little River below Scopini Cut-off...	2, 323. 99
For examination of Sale and Murphy Outlet.....	101. 20
For the survey of Red River.....	4, 773. 90
	<hr/>
Total.....	36, 831. 39

COMMERCIAL STATISTICS.

In the past fiscal year Red River was navigable between Shreveport and the mouth during July, and from October 1 to June 30. During August and September the river was at a very low stage, and for part of that period Montgomery, 161 miles below Shreveport and 52 above Alexandria, was the head of navigation. Between Shreveport, La., and Fulton, Ark., the river was navigable from November 6 to May 16, and from Shreveport to Garland, for small steamers, the entire year.

The following steamboats were engaged in the Red River trade during the year:

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Round trips.	Between what places.	Number of passengers.
					Light.	Loaded.			
		<i>Feet.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>Ft. in.</i>	<i>Ft. in.</i>			
Valley Queen.....	410. 83	190. 6	35. 8	5. 6	2 6	8 6	23	Shreveport and New Orleans	350
Garland.....	261. 42	162. 0	30. 0	4. 8	2 0	5 6	21	do	630
Hallette.....	265. 90	161. 0	30. 5	4. 5	2 0	5 6	27	do	880
John D. Scully.....	285. 70	215. 0	34. 6	4. 5	2 0	5 6	13	do	260
							6	do	72
Nat. F. Dortch.....	302. 88	164. 0	28. 8	3. 5	1 6	4 0	80	Shreveport, Gilmer, and Garland	230
							10	Shreveport and Jefferson	60
							28	do	130
Friendly.....	66. 76	120. 0	26. 6	3. 3	0 11	3 0	18	Shreveport, Gilmer, and Garland	120
							4	Fulton and Lanesport	
E. B. Wheelock.....	254. 49	160. 0	30. 0	4. 9	1 8	5 6	43	Shreveport and Alexandria	998
C. E. Satterlee.....	254. 49	162. 0	30. 0	4. 5	1 8	5 6	41	do	998
Belle Crooks.....	78. 43	91. 0	22. 0	3. 0	1 6	3 0	13	Fulton and Garland	63
Marco.....	43. 9	104. 3	19. 0	2. 6	(*)	(*)	1	Fulton and Lanesport	130
John Gilmore.....	503. 9	183. 0	34. 0	6. 0	(*)	(*)	1	Shreveport and Garland	
							1	Knox Point and Mouth Black River	

* Not reported.

NOTE.—All stern-wheel steamboats.

1960 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

The freights by river are given below, with a comparison with the 2 years preceding:

Articles.	1890-'91.	1889-'90.	1888-'89.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Cotton	21,613	18,838	12,593
Cotton seed	12,249	14,140	11,975
Hides and skins	212	35	97
Livestock	38	58	92
Lumber	16,523	4,519	
Staves	81	58	
Stone			4,600
Cotton-seed meal	10,000		
Sundries	2,719	136	873
Total down freight	63,435	37,726	29,670
Return freights	30,051	28,650	19,780
Total	93,486	66,376	49,450
Estimated value	\$9,185,000	\$8,820,310	\$5,370,000

In addition to the above: From Onachita River, entering Red River at mouth of Black River, 221,191 tons. The value of which is estimated to be \$9,130,000.

The following table shows the receipts and shipments of cotton at Shreveport, La.:

	1890-'91.	1889-'90.	1888-'89.
Sources of receipts:	<i>Bales.</i>	<i>Bales.</i>	<i>Bales.</i>
By rail	39,890	25,476	30,331
By wagon	37,723	40,028	35,450
By river	14,836	8,397	12,368
Warehouse receipts	92,449	74,402	78,143
Shipments:			
By Texas and Pacific Railroad	23,311	23,690	20,532
By Vicksburg, Shreveport and Pacific Railroad	15,564	20,813	24,029
By Shreveport and Houston Railroad	13,880	12,529	494
By St. Louis and Southwestern Railroad	15,039	8,820	24,123
By river to New Orleans	19,218	8,412	8,956
Total	86,992	74,264	78,134

The water route from Shreveport, La., to Jefferson, Tex., through the lakes and Cypress Bayou, was navigable from December 1 to the end of the fiscal year. The number of trips made by steamboats is given in the list of boats above, and the freights reported were as follows:

Freights.	1890-'91.	1889-'90.
	<i>Tons.</i>	<i>Tons.</i>
Cotton	625	200
Cotton seed	300	25
Lumber	83,400	(*)
Sundries	1,825	
Total down freights	85,050	225
Return freights	700	3,300
Total freights	85,750	3,525
Estimated value	\$748,000	\$304,325

* Not reported.

The competing routes of transportation for the trade of the Red River Valley below Fulton, Ark., are as follows: The river is crossed by the St. Louis, Iron Mountain and Southern Railway, at Fulton, Ark., by the St. Louis and Southwestern Railway (Cotton Belt Route), at Garland, Ark., and by the Vicksburg,

Shreveport and Pacific Railroad at Shreveport, La., and a branch of the Cotton Belt System from Lewisville, Ark., 8 miles east of Garland, runs parallel to the river to Shreveport. The Texas and Pacific Railway runs nearly parallel to the river, and touches at Alexandria, Boyce, Shreveport, and other points on the main river, and at Jefferson, Tex., on Cypress Bayou, and connects at Texarkana, Ark., with the Cotton Belt and St. Louis, Iron Mountain and Southern. This railroad has a steamboat line on Red River between Alexandria and Shreveport, La. Morgan's Louisiana and Texas Railroad, a branch of the Southern Pacific, runs from Alexandria to the main line. Shreveport is the eastern terminus of the Shreveport and Houston Railroad. The Houston, Central Arkansas and Northern Railroad, a branch of the Missouri Pacific System, is constructing a bridge at Alexandria, and two projected lines contemplate crossing at the same place. Jefferson, Tex., at the head of navigation on Cypress Bayou, has transportation by the Missouri, Kansas and Texas Railway in addition to the Texas and Pacific Railway mentioned above.

V 2.

IMPROVEMENT OF RED RIVER ABOVE FULTON, ARKANSAS.

An examination of Red River above Fulton, Ark., was made in 1884, in accordance with the requirements of river and harbor act approved July 5, 1884, and the plan recommended for its improvement contemplated removal of snags and drift, etc., to secure safer high-water navigation between Fulton and the mouth of Kiamichi River, Indian Territory. (Report Chief of Engineers, 1885, pages 1617-1627.) This part of the river is 138 miles long.

The estimated cost of putting this stretch of river in fair condition for navigation at high stages was \$10,000, if expended in one season's operations. In the last annual report \$2,000 additional was asked, to be applied to going over and completing the work.

The appropriations have been as follows:

By act of—	
August 5, 1886.....	\$7, 000
August 11, 1888.....	3, 000
September 19, 1890.....	2, 000
Total amount appropriated.....	12, 000

In the fiscal year 1887 the hand-propelled snag boat *Harry Breck*, with steam capstan, was built at Fulton at a cost of \$4,000, and during the succeeding 2 years this boat was employed in removing obstructions until the funds were exhausted.

The improvement was carried on under the direction of Capt. H. S. Taber, Corps of Engineers. In December, 1888, after the appropriation had been expended, he transferred the snag boat *Breck* to this district for temporary use in Red River below Fulton; and in November, 1890, the work of improving Red River above Fulton was transferred to my charge. Under authority of the Chief of Engineers the snag boat was sold to the work of improving Red River, Louisiana and Arkansas, for \$1,500, and this amount applied to the removal of obstructions above Fulton, in connection with the appropriation of September 19, 1890.

Operations during the fiscal year ending June 30, 1891, were as follows:

The United States snag boat *C. W. Howell*, M. B. Lydon, master, had been working in the river below Fulton, reached that place January 14, and continued upstream. On arriving at the Texarkana and Fort Smith Railroad Bridge, 24 miles above Fulton, January 15, the channel through the draw was found jammed with drift and the draw pier

careened toward the left channel. The *Howell* cleared the jam and worked up stream to 5 miles above Mill Creek and 45 miles below Kiamichi. By that time, January 22, the water was falling rapidly, with about $3\frac{1}{2}$ feet on the bars, and the boat returned and worked in the 20 miles above Fulton. The 1st of February the river commenced rising, and the *Howell* was sent to Shreveport to tow the *Breck* to Kiamichi if possible. The boats started upstream February 5, and February 10 the *Breck* was dropped at Joiner Ferry Bar, 1 mile above Cook Landing, Ark., and $38\frac{1}{2}$ miles above Fulton, the water having fallen so rapidly that the *Howell* could go no farther with safety. February 22 another rise set in, and the *Howell* worked up to within 30 miles of the mouth of Kiamichi before the fall was sufficient to necessitate turning back. On the way down the *Howell* towed the *Breck* back to Fulton, reaching that place February 27.

The following is a summary of the work done by the *Howell*:

Snags pulled.....	272
Stumps pulled.....	1
Logs removed from channel.....	684
Jams removed.....	1
Side jams removed.....	5
Leaning trees cut.....	111

Towing snag boat *Breck* from Fire Point, Louisiana, to Joiner Ferry, Arkansas, and from Texarkana and Fort Smith Railroad Bridge to Fulton, Ark.

The hand-propelled snag boat *Breck*, W. W. Moore, overseer, commenced work at Rosebaugher Landing, Texas, February 11, and continued upstream 10 miles to Saunderson Landing, Arkansas, where operations were suspended February 24. The boat started downstream on the latter date, but was delayed by high winds until overtaken by the *Howell*. The *Breck* removed 40 snags, doing some heavy work, but it has not been found economical to use the boat for this class of obstructions, as it is better adapted for clearing the banks and removing shore snags.

The work of the past year practically completed the project for this improvement, and has been commended by the steamboat men. The obstructions were of the heaviest kind, consisting principally of large snags and piles of drift, which forced the river out of its natural channel and made navigation difficult and dangerous. A fair steamboat channel for high-water navigation was cleared by the *Howell* to within 30 miles of the upper limit, as far as the boat was able to go on the stage of water, and it was intended that the *Breck* should work over the upper portion before it was found impracticable to tow the boat that far up. This part of the river is navigable by the smallest boats, and during high stages only. Lanesport, Ark., near the Indian Territory line, 74 miles above Fulton, usually is considered the upper limit of navigation, but boats make occasional trips to Kiamichi on the highest stages of river. Below the Kiamichi Red River has no tributary of consequence except Little River, which enters the main stream 2 miles above Fulton. The oscillations are so rapid that frequently boats can run in one direction only on a single rise, and have to regulate their trips by the quantity and duration of rainfall in the upper-river country.

The banks are covered with trees constantly caving or sliding into the river, and if the removal of obstructions from the channel were continued, and the timber cleared from the banks to stop further accumulations, navigation would be safer and there would be less drift to contend with in the river below Fulton, but it is doubtful if the boating period would be lengthened or the upper limit extended.

I recommend one of two courses in regard to this part of Red River; either that no further work be done in it until there shall be a pressing demand for a considerable improvement from Fulton upward, including Little River, both to gain a better and longer period of navigation and to help drain the adjacent lands; or else that a liberal amount, say not less than \$10,000, shall be given in a single appropriation to allow the systematic clearing of the banks and removal of logs from the channel way to permit the bottom to scour. In no other way can the money be expended economically or any appreciable results obtained. The cost of organization and administration will be about the same for a small appropriation as for a large one, and the cost of getting the plant to the scene of operations and returning it to the fleet or other work will reach together nearly \$1,000. The estimate is submitted with the idea of sending all of the snag boats in Red River to work together under one management just as soon as the spring floods begin to subside, the snag boats to be employed on the wrack heaps and heavy obstructions, and the chopping parties to clear the banks, so that all loose stuff shall go out on the first and succeeding rises. This will allow about 6 weeks to 2 months' work of the snag boats, the lightest draft boat being kept perhaps somewhat longer, and the boat with the chopping party continuing on downstream on bank work and small jams. About \$1,000 should be held in reserve to send a snag boat over the whole the following season to dislodge heavy drift and pick up channel snags.

Nothing was known in this office about the Texarkana and Fort Smith Railroad Bridge, already mentioned, until the snag boat *Howell* went above Fulton in January. It appears, however, that a charter had been granted by Congress with the usual conditions, and the builders assert that plans were sent to the Secretary of War before construction was undertaken. No surveys or plans were submitted to Captain Taber, but the promoters of the railroad wrote to him before the charter was granted, after which he was unable to get any information on the subject, probably because the project was abandoned for several years. Complaint having been made that the bridge would obstruct navigation, I made an examination of the river and bridge at the point of crossing, and directed the president of the company to prepare a map and plans, which have not yet been submitted, owing to continued floods in the upper river. It is probable that deflecting dikes placed about half a mile above the bridge will divert the channel under the draw span, so as to give reasonably safe passage for any boat that can navigate this part of the river.

Money statement.

Amount appropriated by act approved September 19, 1890.....	\$2,000.00
Amount received from sale of snag boat <i>Breck</i>	1,500.00
	<hr/>
	3,500.00
June 30, 1891, amount expended during fiscal year	3,273.82
	<hr/>
July 1, 1891, balance unexpended	226.18
July 1, 1891, outstanding liabilities	1.07
	<hr/>
July 1, 1891, balance available.....	225.11
	<hr/>
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	10,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

1964 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

COMMERCIAL STATISTICS.

This part of Red River was navigable in the past fiscal year for small boats from the latter part of August to the middle of April.

List of boats engaged in trade.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Round trips.	Between what places.	Number of passengers.
						Light.	Loaded.			
Friendly.....	Stern-wheel steamboat ..	66.76	120.0	25.6	3.3	0 11	3 04		Fulton and Lanesport, Ark.	.....
Belle Crooks.....	do	78.43	91.0	22.0	3.0	1 6	3 01	8	do.....	130
Dell Taylor*.....	do								do.....	

*Fulton and Little River, towing timber; no further information obtainable.

Summary of freights carried during the year.

	Tons.
Cotton.....	774
Cotton seed.....	353
Lumber.....	244
Provisions.....	334
Grain.....	418
Miscellaneous.....	100
Total.....	2,223
Estimated value (in round numbers)	\$265,000

The river from the mouth of Kiamichi, the upper limit of improvement, to Fulton is paralleled by a branch of the Texas and Pacific Railroad from Texarkana to Paris, Tex., connecting at the latter place with the St. Louis and San Francisco Railroad, which crosses Red River at Arthur, Tex., above the head of navigation. The Texarkana and Fort Smith Railway (under construction) crosses the river about 10 miles north of Texarkana, and the St. Louis, Iron Mountain and Southern Railway crosses at Fulton.

V 3.

IMPROVEMENT OF OUACHITA AND BLACK RIVERS, ARKANSAS AND LOUISIANA.

Ouachita (the Indian name for black) River has its source in Polk County, Ark., in the Ouachita Mountains, and following an irregular course flows in a general southeasterly direction through Arkansas and Louisiana until joined by Tensas and Little rivers at Trinity, La. Below this junction it is known as Black River and flows in a southerly direction, entering Red River about 40 miles above its mouth. The entire length of Ouachita River is about 500 miles and Black River is 47 miles long.

Examinations were made by the United States in 1871 and a project submitted for temporary improvement, from Arkadelphia to the mouth, by the removal of snags and by dredging at the worst bars, at an estimated cost of \$98,300 (334-346, Report Chief of Engineers, 1871). Work was commenced the same year. In 1871-'72 a survey from Camden, Ark., to Trinity, La., was made, the report on which recommended improvement by locks and dams (367-374, Report Chief of Engineers, 1872), and a contract was made for timber for foundations of three locks. In

February, 1873, the maps and notes of the survey were reviewed by a board and a new survey was ordered by the Department, which was finished in 1874. In view of the cost of slackwater navigation, as compared with the business reported, it was considered inexpedient to go on with the construction of locks and dams, and, upon the recommendation of the officer in charge, the work was suspended and the funds applied to the construction of a snag boat to be used in the removal of obstructions, wrecks, leaning timber, etc., and in the improvement of shoal places by dikes and dredging. This is essentially the approved project under which operations have been carried on since 1874 between Camden, Ark., and the mouth of Black River, a distance of 341 miles.

No estimates of cost are given, as the nature of the work requires that it be continuous. (Reports Chief of Engineers, 1874, Part I, page 352; 1884, page 1386; 1887, page 1487; and 1889, page 1631.)

The appropriations have been as follows:

By act of—

March 3, 1871	\$51, 000
June 10, 1872	100, 000
March 3, 1873	60, 000
August 14, 1876	12, 000
June 18, 1878	10, 000
March 3, 1879	10, 000
June 14, 1880	8, 000
March 3, 1881	12, 000
August 2, 1882	12, 000
July 5, 1884	15, 000
August 5, 1886	17, 500
August 11, 1888	20, 000
September 19, 1890	15, 000

Total amount appropriated 342, 500

The amount expended under the present project to June 30, 1890, was \$206,737.24. The iron-hull snag boat *O. G. Wagner* was purchased for this work in 1875, and repaired with new $\frac{1}{8}$ -inch steel bottom in 1886, and the small wooden steamer *Hooker* was purchased in 1888 and fitted up for light snagging in Ouachita and tributaries. The work done consisted principally of removing snags and logs and tree slides from the channel and cutting leaning timber. Besides the removal of obstructions, an increased depth was gained at some of the shoals by the construction of stone and brush wing dams.

In the fiscal year ending June 30, 1891, operations were as follows:

On August 6 the snag boat *Hooker*, Watkins Decker master, left Monroe, La., and removed tree slides in Pargoud Bend, a short distance below. On completion of this work the boat continued down to Catahoula Shoals, where it was used by the survey party, and later at Alexandria, La., after which it was laid up at the latter place until the appropriation of September 19 was made. As soon as the bill became a law some minor repairs were made, and October 12 the boat proceeded to the mouth of Black River and commenced removing obstructions. Work was continued upstream to Monroe, where the boat was laid up November 17 on account of high water. Operations consisted chiefly of the removal of tree slides, which in some cases extended entirely across the stream.

The following is a summary of the work of the *Hooker*:

Snags removed from channel	241
Stumps removed from channel	35
Side jams removed	2
Shore snags and stumps removed	214
Leaning trees removed	193
Trees girdled	1, 119

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The chopping party which had been employed on the river above Camden, Ark., reached that place November 4, and November 5 commenced work on the river below. Operations were carried downstream to Newport, Ark., 23½ miles below Camden, where they were suspended January 1 by high water. To the latter part of May the river was at too high a stage for work, but by June 1 it had fallen sufficiently, and on that date the chopping party was reorganized, and at the end of the year operations had progressed down to Millers Bluff, 32 miles below Camden. The work of this party consisted of cutting all overhanging timber on the points and in the bends into short lengths, girdling trees, and removing snags as far as practicable with explosives and hand capstan. Operations were conducted under the supervision of Overseer John T. Burkette, who reports the following work done:

Snags removed from channel	1, 033
Shore snags removed	1, 417
Leaning trees removed	20, 849
Trees girdled	8, 916
Logs on banks cut up	1, 681
Square yards willows and brush cut	6, 767
Lineal feet brush dams built	250

The snag boat *Howell*, M. B. Lydon master, was sent from Shreveport downstream to the mouth of Red River the early part of June, and June 12 entered Black River. Black River and the lower part of Ouachita were too high for advantageous work, and as the water was falling rapidly the boat proceeded upstream as far as possible. On reaching Rock Row, just above the mouth of D'Arbonne and 17½ miles above Monroe, June 15, there was but 3 feet of water on the bar and the pilot reported that it would be unsafe to go farther upstream on a falling river. The boat worked back to Columbia, 59 miles below Monroe, but on the 17th of June a rise set in and the boat rounded to and worked up to 1 mile above Ouachita City, 20½ miles above the mouth of Black River. June 24 the *Howell* started back downstream and at the end of the fiscal year had worked down to Log Town, 23½ miles below Monroe. All the snags in sight were removed and the sweep chain was used for removing hidden obstructions. The draw of the railroad bridge at Monroe was cleared of a small sunken barge, snags, and railroad iron. The following is a summary of the work reported:

Snags pulled	126
Stumps pulled	33
Shore snags cut	96
Leaning trees cut	1, 182
Wreck removed (small barge)	1

Work with the *Howell* will be continued down to the mouth of Black River, and the chopping party in the upper part of the river will continue operations downstream as long as they can be pursued to advantage, and it is believed that it will be able to reach the Arkansas and Louisiana line, or possibly Monroe, before high water sets in.

As the snag boat *Wagner* is of light draft and has sufficient power for all but the heaviest work it is detached and used in other streams occasionally. When the Ouachita is at suitable stage it will be used in the upper river as far as Camden to supplement the work of the chopping party now moving downstream from the head of navigation.

The snag boat *Hooker* has been used in Ouachita and in the tributaries, and also in Red River and Big Black. The boat has had very hard service and is now laid up at Vicksburg, the hull having become too soft to calk. As there are no facilities for repairing boats within 300 miles, and as it is impossible to estimate the cost of repairing so old

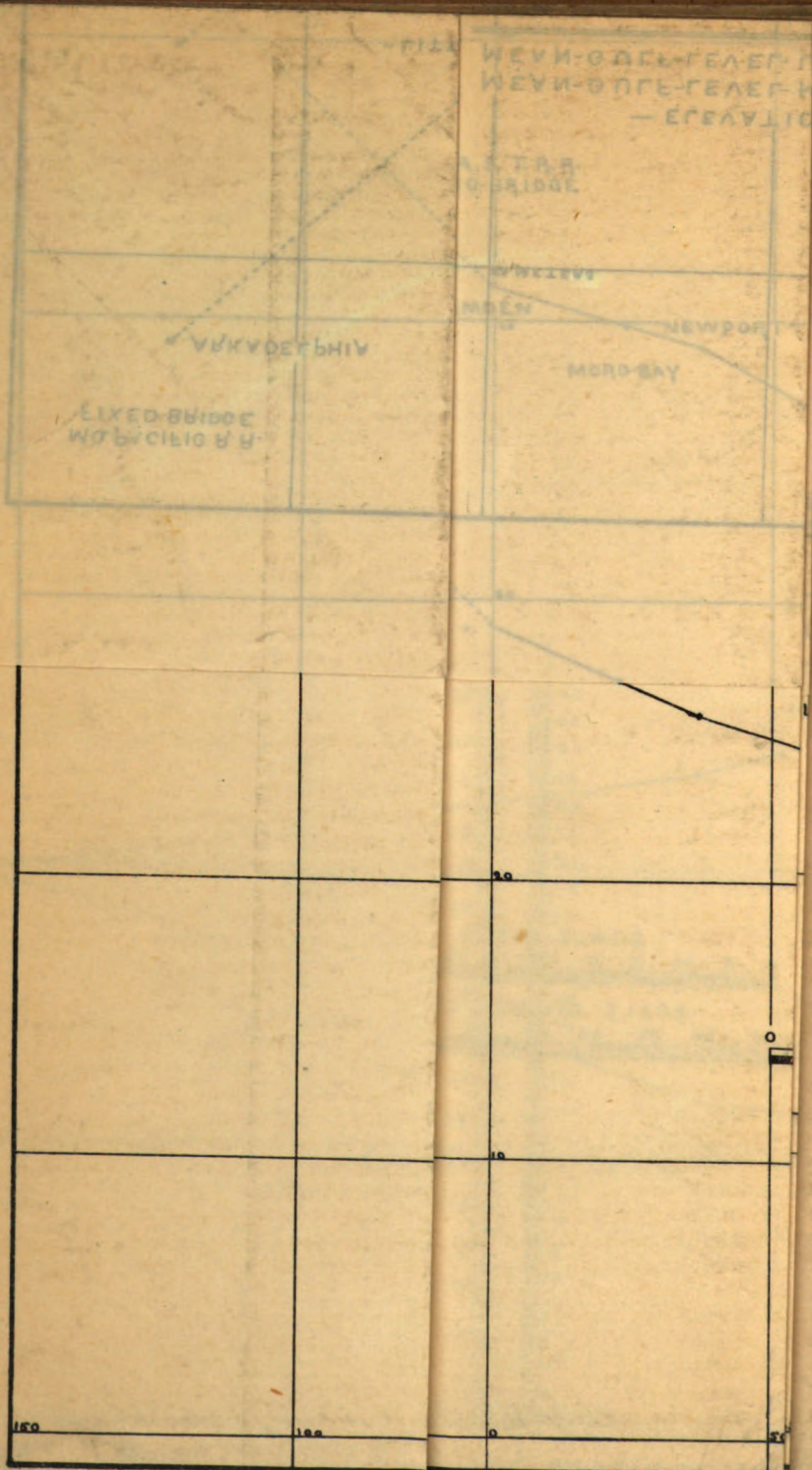


Photo-Lith, by A. HOEN & CO., Balto., Md.

at low water 2.6 metres. Neither is there any necessity for closing the mouths of the creeks, for an examination of them for several miles failed to reveal any indication of their bringing down the gravel which forms the bars at the shoals. Their beds are not composed of gravel to any considerable degree, but are of mud, and the gravel found in them is mostly flint, feldspar, and trap rock, while that on the bars is mostly roughly rounded limestone. The outflow of water from these creeks in time of flood does probably aggravate the trouble on the shoal by cross currents. I conceive the shoals to be due to a combination of an enlarged channel at time of high water at and above the mouth of Little Creek; a want of coincidence of the high and low water channels over the shoals; and the natural obstruction of a ledge of rock across the bed.

As far as could be ascertained by boring and blasting a hole near the water's edge to a depth of 2.5 metres below the water surface, the bed is composed of alternate layers of soft limestone in nearly horizontal veins about half a metre thick, and a bluish clay about 1 metre thick, with loose gravel overlying. It would not be difficult, therefore, to dredge a channel 80 square metres in cross section, which would confine the high and low water way, if located along the left bank, where the high water tends to flow, depositing the dredged material in a wing dam from the right bank to the head of the gravel bar. This would involve moving 7,350 cubic metres at a cost estimated at \$2,940. The removal of the projecting point of rock on the left bank above the gravel bar, and also the point immediately below the mouth of Little Creek, would be of great benefit, and the material if deposited in a training wall along the left shore in the bend above would reduce the high water width. This necessitates moving 26,896 cubic metres, costing \$10,758. That is to say, for the proper rectification of the shoals to give a depth at lowest stage of 1.6 metres requires an expenditure of \$13,698, or including engineering and contingencies, \$15,000.

The depth on Bayou Louis Bar is now ample for present needs and would probably be still more increased by the work suggested at the shoals above.

Since the project for improving Ouachita River by locks and dams was laid aside, three examinations have been ordered with a view to reviving the subject. The first report was made by Major Miller in 1883, and the others by myself in 1887 and 1889. All agree in recommending that Major Benyaure's project, approved by the Department in 1874 and under which operations have been conducted since, should not be abandoned until the country should be more thickly settled and an increased trade developed which would justify a large expenditure for permanent improvement. Without an exhaustive survey it would be only guess work to estimate the cost of a slack-water system from Camden to Red River. Former surveys would be of little value, except as reconnaissance maps, as even the latest is 18 years old. The probable or feasible sites for locks and dams, the nature of foundations, the limits of lift, the amount of revetment and levees, and of lands that would be declared valuable only by reason of overflow due to the dams; none of these questions can be settled by the information now on hand. A survey of the grade necessary to obtain the information would be an expensive undertaking, involving not only Ouachita River, but a considerable part of all the tributary streams; and unless there should be a probability that a plan involving an expenditure of \$3,000,000 or more would be entertained such a survey would not be justified.

To give a comprehensive view of Ouachita River and tributaries I have compiled the map submitted herewith, showing the drainage basin from Arkadelphia to Red River, which furnishes a high water navigation of 1,600 kilometers (1,000 miles).

Having connected the lines of 1871 and 1874 with the precise bench of the Red River survey at Monroe, and the Delta survey bench of 1858 at Harrisonburg, the high and low water marks were recovered between Camden and Trinity with a certain degree of approximation; while those at the mouth of Black River were derived from the lines on Red River, and those at Arkadelphia from the levels of the Iron Mountain Railway.

The agreement of the railroad levels at Little Rock and Fulton with those of the Coast Survey and Engineer Department warrants the belief that the heights at Arkadelphia may be accepted. The hydrograph shows at once that no money should be wasted on permanent improvement above Camden; that Camden is the natural head of navigation at ordinary stages, and the river above almost a mountain torrent, as might be supposed from the oscillations at Camden, where the river at times rises as much as 15 feet in a night.

The great range in the lower river is due largely to overflow from Mississippi River through Bayou Bartholomew, Boeuf River, Bayou Lafourche, and Tensas and Maçon, but as the main levees are enlarged and consolidated the supply from that source will be cut off and the flood heights greatly diminished.

Fortunately for the interests of navigation and for the safety of any permanent works that might be adopted, Ouachita River is comparatively free from drift, in marked contrast to Red River, which it joins through Black River; and in the lower reaches the banks are far more stable than in most of the streams in this district, and their conditions probably would make it safe to repair old levees and build new without large expenditures for revetment. The map and hydrograph will be amended as additional information is obtained, and to hasten this work it is recommended that additional gauges be established and the most important points connected with the Cairo datum. Camden, Ouachita City, Columbia, Harrisonburg, and Trinity can be connected by comparatively short lines, but the first and the last two are of more immediate value than the others and should have precedence.

It is also recommended that a reconnoissance be made in the lower river to determine the condition of the old levees and the amount it would require to restore them in connection with the parish levee boards. This would be done if the survey should be authorized, and is important enough to warrant an expenditure of \$5,000 in case the survey should be postponed. With regard to the latter, I can not do better than quote from my report of 1890, as no action was taken on the subject at the last session of Congress:

In answer to your indorsement of December 9, on letter from Hon. Charles J. Boatner to the Secretary of War, asking for estimate of cost of survey of Ouachita River to Camden, Ark., with a view to securing permanent navigation by means of locks, I have the honor to submit the following:

A number of surveys, examinations, and reports have been made upon the subject of permanent improvement of Ouachita River, the last by me under date of February 12, 1889, giving a brief summary of plans, estimates, etc., which is published in Appendix W 22, Report of the Chief of Engineers, 1889.

The survey of 1871, upon which the first estimates were made, was condemned by a Board appointed by Colonel Simpson, and so many errors were found upon comparing the maps and notes with the survey of 1873 as to render it valueless even as a reconnoissance.

The report of the Board, with a review of the same, was forwarded to the Chief of Engineers by Colonel Simpson in his letter of March 11, 1873. The subject is discussed again by Major Benyard in his report on the resurvey of 1873 (Report of the Chief of Engineers, 1874, Part I, page 352). The survey of 1873 is not discredited, and doubtless can be used to a certain extent, but how far I can not estimate, as it was made under conditions that do not now exist. I presume the original map and plans are on file in the Engineer Department, but the field notes and copies of the maps, with a limited amount of topography, are at hand, and from such study as I have been able to give them, in the brief time that I could spare, I should say that, as they will be over 17 years old by the time field work could be resumed should a new survey be ordered, their value for purposes of estimate must be limited.

The reasons for this opinion are based upon the facts that Ouachita River, being an alluvial stream, has undoubtedly undergone considerable change since 1873, and especially that all the eastern tributaries are now, or soon will be, deprived of a great part of their supply by the closing of the Arkansas and Louisiana lines of

levees along Tensas Front, and will be limited hereafter to draining their own water sheds.

The amount of money spent by the United States in combination with the States and parishes, corporations, and private parties in the construction of new levees and repair of old is so great as to warrant the belief that no expense will be spared in the future to maintain the west line of levees.

Now since canalization is generally accepted as the only certain means of giving permanent navigation to a river like Ouachita, the minimum water supply must be determined first of all, and to do this requires that the survey of Ouachita River should embrace the principal tributaries from Camden to Red River.

These are Little Missouri, Moro Bay, Saline River, Bayou D'Arbonne, Bayou Bartholomew, Bayou Bœuf (Bœuf River), and Tensas River and Bayou Maçon. The map of the alluvial valley of the Mississippi River, issued by the Commission in 1887, shows most of the valley of Ouachita and tributaries formerly overflowed, and while much of this will be reclaimed by the closing of Tensas Front, it will be important to know the amount that might be flooded by backwater due to dams on Ouachita, to settle questions of land damages, etc., and this would necessitate frequent transvalley lines.

The first thing in order should be precise leveling on Ouachita from Arkadelphia or Camden to Red River, and a few trial lines from the main river to the tributaries, to ascertain the probable lengths of the latter that would require the same or nearly equal grade of survey. I say the same or nearly equal grade, because if Ouachita is to be canalized it is hardly to be doubted that the dams could be so placed as to give no inconsiderable slackwater navigation to the tributaries at the same time; while on the other hand the tributaries must play an important rôle in limiting the heights of dams and lifts of locks, and hence in deciding upon the number and position of them in the main river.

Assuming for example that both banks of Ouachita are high enough to allow a lock of 8 to 12 feet lift below Bœuf River, a slackwater depth of about 4 feet might be obtained for a distance of 40 to 60 miles on Ouachita and Bœuf Rivers at the same time, but only, perhaps, by flooding a greater or less amount of land between the two streams. Now, the only information I have in regard to the lands between Ouachita and Bayou Bœuf that I can offer as fact is, that on the line of the Vicksburg, Shreveport and Pacific Railway, the land is about 20 feet lower at Bayou Lafourche, about midway between Monroe and Girard, than at the Ouachita or Bayou Bœuf, and the map indicates that in the neighborhood of Columbia the drainage is indifferent towards Ouachita or Bœuf, and may flow from one to the other according to variations in respective stages.

I think enough has been said to show the necessity of an exhaustive survey of the whole valley. The information should be so complete as to leave nothing to chance, and therefore the survey should cover precise levels along both banks and frequent transvalley sections; high and low water slopes, discharge and sediment observations; topography, taking in the valley for a mile on each side, or more, if necessary, and connecting with the principal tributaries at intervals; hydrography; sections and longitudinal soundings; secondary triangulation; special examinations and borings at probable sites for locks; permanent bench-marks and monuments; projection of maps; computation, office work, etc.

The estimates for locks and dams heretofore submitted vary from, say, two to six millions of dollars, and in my opinion the latter is none too small for a system of locks and dams between Camden and Black River, considering the nature of the foundations probably to be encountered.

The rise and fall at Camden is 39.25 feet; at Monroe, 46 feet; at Bœuf River, over 52 feet, and at Trinity 53.4 feet, so that it is clear that whatever system were chosen, whether fixed or movable dams, locks of high or low lift, none but the most substantial work would be admissible, as complete submergence of the locks and maneuvering engines, boilers, etc., would have to be provided for at any stage over, say, 20 feet above low water. The great variation in rise and fall, as stated, though under the changed conditions it may be much less in the future, warrants the belief that both revetments and levees may be required to prevent flanking the dams and locks, a disaster that would not be local, and to be remedied by the expenditure of a hundred thousand dollars or so, but one that would mean the destruction of the system or the interruption of navigation for years and the expenditure of an immense sum for its restoration. Six millions of dollars would not be an extravagant sum to pay for a permanent navigation of Ouachita River that would also give from 40 to 100 miles on each of its large tributaries, say about 1,000 miles in all, giving an average of \$6,000 the mile. But whether the ultimate cost should be found to be greater or less than the estimates heretofore submitted, true economy demands a most thorough and exhaustive survey, always a very expensive undertaking.

As much of the country to be gone over is unsettled, it would require that the

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parties should be maintained in the field, in camp, or on quarter boats for two seasons, or longer if operations should be interrupted by high water or sickness; high pay in the field and office, as only the best men should be employed, and expensive instruments suited to the grade of work demanded.

It is very difficult to make an estimate, because it can not be determined how much work will be needed on the tributaries until they have been examined, nor how much of the survey of 1873 can be used until it has been reviewed both in the office and in the field.

First-class work can be done for about the following rates per mile: Secondary triangulation, \$125, if the country is reasonably open, so that high stations or much cutting will not be required; topography, hydrography, and precise levels along the river, \$150; precise levels and transit lines across country, \$50; discharge and sediment observations, according to the number of stations and time allotted. The last is very uncertain, on account of interruptions and delays by floods and unfavorable conditions.

Ouachita and tributaries are subject to sudden and considerable floods, though the highest water occurs generally in March and November, so that it is probable that field work could be carried on for about 9 months in the year. On this basis, and making allowances for interruption from sickness and bad weather, I estimate that the survey could be completed and the notes and estimates prepared in about 2 years and a half, and at a cost of \$150,000, or about 2½ per cent. of the estimated cost of the improvement.

The amount estimated for the fiscal year 1892 can be expended to advantage of commerce and navigation in continuing operations under the present project. In addition to the work of snag boats I recommend the systematic clearing of the banks for some distance back. This is especially necessary in the bends and narrower portions of the river for the immediate benefit of navigation, but should be continued throughout the whole stream to prevent the formation of obstructions. Dredging should be tried also at the most obstinate shoals, and the construction of inexpensive wing dams, built chiefly with the material cut from the banks.

DETAILED ESTIMATES.

For the snag boat service	\$16, 000
For plant and work at Catahoula Shoals	20, 000
Rebuilding snag boat Hooker	3, 500
Expenses of chopping parties	8, 000
Repairs and outfit	2, 000
Dredging in Black River	2, 000
Gauges, leveling, and reconnoissance	5, 000
Assistant engineers and draftsmen	2, 000
Survey of Ouachita River	150, 000
Office expenses, stationery, mileage, and contingencies	1, 500
Total	210, 000

The lower part of Ouachita River, known as Black River, which is the interpretation of Ouachita, is formed at Trinity by Ouachita, Bayou Ha-Ha, Tensas River, and Little River. I made a reconnoissance and map of Black River in January, 1890, and found it to be about 47 miles long, tortuous, and obstructed by shoals, which had as little as 16 inches over them in extreme low, while in great floods the depth exceeded 54 feet. Little River is a stream formed by Bayou Castor and Dugdemona River, and reaches Ouachita through Catahoula Prairie, which becomes a lake in high water. The portion between Catahoula Lake and Trinity, some 25 miles, has been improved by the expenditure of \$2,500, appropriated by the act of August 11, 1888. The effect of this work was to stimulate trade, and the commercial statistics show a very large increase over those given in former reports. As the appropriation of 1888 was made to complete the work in accordance with the project, no further estimate was submitted, and the stream was dropped from the list of rivers in this district. It is referred to now on account of the amount of business contributed to Ouachita River. The same amount could be spent on this stream with great advantage.

Money statement.

July 1, 1890, balance unexpended	\$7, 174. 89
Amount appropriated by act approved September 19, 1890	15, 000. 00
	<hr/> 22, 174. 89
June 30, 1891, amount expended during fiscal year	9, 398. 34
	<hr/> 12, 776. 55
July 1, 1891, balance unexpended	12, 776. 55
July 1, 1891, outstanding liabilities	241. 67
	<hr/> 12, 534. 88
<hr/> (Amount that can be profitably expended in fiscal year ending June 30, 1893 210, 000. 00	
{ Submitted in compliance with requirements of sections 2 of river and	
{ harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

In the past fiscal year the river was navigable to Camden from the middle of November until the middle of May. The lower part of Onachita and Black River was navigable the entire year, boats generally running to Monroe, but at very low stages Columbia was the head of navigation for New Orleans boats.

The following list shows the steamboats engaged in business on the Onachita and tributaries during the year:

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Round trips.	Between what places.	Number of passengers.
						Light.	Loaded.			
Onachita	Stern-wheel steamboat.	457. 45	216. 0	52. 8	6. 0	3	6 10 0	29	New Orleans and Monroe, La.	2, 175
John Howard	do	329. 69	180. 0	36. 0	6. 0	2	6 7 6	11	New Orleans and Camden, Ark.	520
Alto	do	363. 16	166. 0	34. 6	4. 9	2	6 6 6	13	do	400
St. John	do	382. 24	176. 0	36. 0	7. 0	3	0 8 0	3	do	50
G. W. Sentell	do	198. 57	160. 0	29. 5	4. 8	2	0 6 0	11	do	
								7	New Orleans and Monroe, La.	
Josie W	do	156. 40	140. 9	30. 4	4. 8	2	0 6 0	5	Monroe and Stein's Bluff.	20
								15	Monroe and Poplar Bluff.	100
City of Savannah*	do	585. 55	186. 0	31. 0	5. 0			1	St. Louis and El Dorado, Ark.	
City of Sheffield*	do	329. 74				2	6 7 0	1	do	
Bald Eagle*	do	454. 70	202. 3	30. 0	5. 4	3	6 5 6	2	do	
H. J. Dickey	do	208. 54	167. 0	36. 0	6. 0			5	New Orleans and Texas and Macon.	
Danube	do	232. 32	175. 0	33. 8	5. 1			10	do	
Era No. 10	do	178. 89	136. 0	30. 8	5. 0	2	0 5 0	13	New Orleans and Bayou Beauf.	44
Hibernia*	do	157. 06	135. 0	25. 0	4. 0			1	do	
H. W. Graves	do	31. 22	94. 6	17. 6	3. 0	1	2 3 0	45	Trinity and Bayou Macon.	
								35	Trinity and Rhinehart.	150
Marcus Collins	do	48. 14	98. 0	17. 0	2. 5	1	1 3 0	45	Trinity and Bayou Macon.	113
								50	Trinity and Rhinehart.	300
L. Teal*	do	27. 52	82. 0	12. 2	2. 0	1	6 3 0	45	Trinity and Bayou Macon.	112
Albert Lea	Side-wheel steamboat.	24. 47	64. 8	12. 3	4. 0	2	6 4 0	16	Trinity and Pendarvis.	100
								15	Trinity and Rhinehart.	75
Sallie	Stern-wheel steamboat.	68. 25	109. 0	23. 9	3. 3	1	0 3 0	18	Monroe and Shiloh	45
								4	Monroe and Camden	40
								21	Monroe and Bear House Creek.	65
Sterling White	Side-wheel steamboat.	117. 09	120. 0	30. 5	4. 2	2	0 4 6	20	Monroe and El Dorado, Ark.	209
								1	New Orleans and Monroe.	
Lake Washington	Stern-wheel steamboat.	96. 39	102. 0	24. 0	4. 3	2	0 6 0	3	Monroe and Stein's Bluff.	10
								4	Monroe and Lind Grove, La.	10

* With barge in tow

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Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Round trips	Between what places.	Number of passengers.
						Light.	Loaded.			
Tributary	Stern-wheel steamboat.	93.78	Feet. 83.0	18.6	3.0	1 2	3 2	1	Monroe and Shiloh	
Addie	do	12.54						18	Monroe and Stein's Bluff	
Irwin*	Tug	3.00				2 2	2 4	52	Stafford Point and Prairie Landing.	75
Julia H	do								Connecting boat for Bayou Boeuf.	
Caddo	Stern-wheel steamboat.	40.16				0 8	1 4	1	Mouth Little Missouri and Camden.	
Marco	do	43.90	104.3	19.0	2.6				Connecting boat for Bayou Maçon.	
H. M. Townsend†	do	89.70	116.7	18.0	3.1			1	New Orleans and Camden.	
Gen. Duval*†	do							1	do	
Prince*	do	107.88	120.0	25.0	2.8	2 0	4 6	2	do	
D. C. Fogel*†	do	89.62	121.9	21.6	4.4			1	New Orleans and Saline River.	
May Fisher†	do	52.84	92.0	18.8	4.0	2 5	2 5	1	New Orleans and Trinity.	
Joe*	Tug								Connecting at Harrisonburg.	
Ida B. Cothell†	Stern-wheel steamboat.	57.05	92.7	22.1	3.7				Towing logs, Trinity to Red River Landing.	

* With barge in tow.

† Towboats.

The traffic by river reported was as follows:

	1890-'91.	1889-'90.	1888-'89.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Cotton	21,433	16,652	17,788
Cotton seed	6,583	5,038	2,660
Hides and skins	25	36	23
Live stock	172	62	213
Lumber	16,388	7,951	5,963
Staves	17,888	21,159	8,599
Logs	120,000	50,000	
Rock	18,000		
Miscellaneous	10,856	783	1,096
Total down freight	211,355	101,701	36,342
Return freight	27,842	40,766	24,228
Total freight	239,197	142,467	60,570
Estimated value, in round numbers	\$9,130,000	\$10,234,250	\$8,798,000

The competing routes of transportation are as follows: Ouachita River is crossed by the St. Louis, Iron Mountain and Southern Railway at Arkadelphia, Ark., by the St. Louis and Southwestern Railway (Cotton-Belt route) at Camden, Ark., and by the Vicksburg, Shreveport and Pacific Railroad at Monroe, La. The St. Louis and Iron Mountain road has a branch line parallel to the river from Camden to Gurdon, Ark., and thence by the main line to Arkadelphia. A projected extension of this branch will give direct communication with the Mississippi River at Arkansas City, the part to be built being from Camden to Warren, Ark., a distance of about 50 miles. The Houston, Central Arkansas and Northern Railroad (another branch of the Missouri Pacific System) connects with Arkansas City at McGehee, 12 miles west, and thence runs in a southwesterly direction, about midway between Bayou Bartholomew and Boeuf River, touches Ouachita River and crosses the Vicksburg, Shreveport and Pacific Railroad at Monroe, La., and continues down, parallel to the main river, to Columbia, La. This road is building a bridge across the river at River-ton about 6 miles above Columbia, and is under construction from Columbia to Alexandria, and will cross Little River at the junction of Dugdemona with Bayou Castor.

The Natchez, Red River and Texas Railroad (narrow gauge) runs from Black River Station, opposite Trinity, to Vidalia on the Mississippi opposite Natchez. This road has a small triweekly packet running in Black River to Natchez. The New Orleans and Northwestern Railway, completed from Natchez, Miss., to Rayville, La., crosses Tensas River near its mouth, and the projected extension of this road will cross Bouf River a short distance north of Rayville and Bartholomew near Bastrop, La. The commerce of Little River, which unites with Ouachita and Tensas at Trinity, La., in forming Black River, was reported for the past fiscal year, as follows:

	Tons.
Cotton	1,500
Cotton seed	2,500
Hides and skins	25
Live stock	332
Lumber	225
Staves	900
Logs	60,000
Total down freight	65,482
Return freight	3,856
Total freights	69,338
Estimated value, in round numbers	\$705,000

V 4.

IMPROVEMENT OF OUACHITA RIVER ABOVE CAMDEN, ARKANSAS.

An examination of Ouachita River in Arkansas was made under direction of Lieutenant-Colonel Raynolds in 1870. Above Arkadelphia it was found to be little more than a mountain torrent, at most times very shoal, and in flood too rapid for navigation. Estimates were made for removing obstructions below Arkadelphia to the Arkansas line, \$60,000, and for dredging, \$12,300. (Report Chief of Engineers, 1871, pages 336-337.) The act approved March 3, 1871, appropriated \$25,000 for improving the river below Arkadelphia to the Louisiana line, which was expended in removing obstructions in 1871 and 1872.

Nothing was done for further improvement above Camden until 1882, when an examination of the river from Camden to Arkadelphia was directed by the act of August 2, 1882. The examination was made by Major Miller, who reported that this part of the river was not worthy of improvement and the work not a public necessity. (Report Chief of Engineers, 1884, pages 1351-1355.)

The act approved August 5, 1886, directed a "reëxamination of Ouachita above Camden, Ark.," which was made under my direction in 1887. (Report Chief of Engineers, 1887, pages 1495-1497.) I reported that nothing could be found to recommend an expensive improvement, but that I considered the river between Arkadelphia and Camden worthy of improvement to the extent of cutting leaning timber, girdling trees along the banks, removing snags and logs with dynamite, and building brush dams at the shoals to afford navigation at high stages, at an estimated cost of \$9,000.

The act of August 11, 1888, appropriated \$9,000 "to complete" the improvement.

Work was commenced at Arkadelphia in September, 1889, and carried downstream to Camden, where it was suspended in December. Operations during that period put the river in fair condition for navigation above Camden to Arkadelphia at stages that would permit

steamers to run to the former place, all the work having been done at low water, except a short stretch above the mouth of Little Missouri. No business was diverted to the river, however, and none of the regular Ouachita boats went higher than Camden, giving the reason that as the merchants of Arkadelphia had taken no steps toward shipping by river Camden was still regarded as the head of their trade.

The work in 1889 was done well in spite of occasional interruptions by sudden rises, but it was expected that a great deal of the timber that had been cut would lodge in the stream the first season, and a considerable sum was reserved to be used in going over the whole stretch during the next low water.

During the fiscal year ending June 30, 1891, operations were as follows:

A chopping party was organized at Camden July 23 and the boats and outfit used the preceding year put in order by July 28, and the party started upstream to resume the removal of obstructions. As the water was at a low stage, progress was slow and the boats were detained more or less at every shoal. There was less than 4 inches on Tulip Bar, and brush dams were built to concentrate the flow, by which the depth was increased to 6 inches, but as the quarter boat drew about 13 inches log rollers were made and the boat hauled upstream for over a quarter of a mile. At the rapids a number of large bowlders were removed before the boat could pass. The mouth of the Little Missouri, 33 miles above Camden, was reached August 12, and as this tributary furnishes a large proportion of the water supply it was not deemed advisable to try to move the boats higher upstream on the low stage of water, but the party was divided and six men with a skiff, battery, and explosives were sent to remove the channel snags above that point. The flat boat worked back downstream, thoroughly removing all obstructions on the way, until September 22, when the river commenced rising rapidly, and the plant was laid up at Old River Cut-off, a few miles above Camden. Complaint having been made of obstructions in the river below Arkadelphia, the available balance was expended between that place and the mouth of Decepier Creek, 28 miles below. October 2-4 the quarter boat was towed to the latter point, but heavy rains set in immediately thereafter, and as there was no probability of doing the work within a reasonable time, the boat was dropped back to Old River Cut-off October 7, and again laid up. By October 22, however, the water had fallen sufficiently to resume work, and a party with skiffs, tools, and explosives was transported by teams to the mouth of Decepier Creek. Work was carried upstream to Arkadelphia and then back over the same stretch of river, dynamite being used freely, and the overseer in charge reported that nothing further which would be called an obstruction could be found, and that with sufficient water to pass the shoals steamboats could go to Arkadelphia without danger. On completion of this work, the party in skiffs returned to the boats, which were dropped down to Camden November 4, to be used on the work of improving the river below that place.

Overseer John T. Burkette, in immediate charge, reported the following work for the year:

Snags removed from channel	1, 467
Leaning trees cut	783
Square yards brush and willows cut	4, 304
Cubic yards rock removed from channel	29
Linear feet brush dams built	800

This work completed the project for improving Ouachita River between Camden and Arkadelphia, Ark., and, as stated in my report of the examination, it should not require attention for many years. No additional estimates are submitted, there being no commerce now or to be developed for some time to come at all commensurate with the cost. Colonel Reynolds stated that dredging would be of great benefit to navigation, but in my judgment it would only aggravate the difficulties. Lieutenant-Colonel Benyaurd's profile shows, as he reports, "that ordinary methods of improvement, such as dredging and rock excavations or wing dams, would involve enormous expense even if practicable," and as these remarks were for the river below Camden they will apply still more forcibly to the river above. Colonel Reynolds speaks of only 12 inches on the shoals, but in extreme low water 3 inches is not uncommon. Even if a system of locks and dams should be found practicable the benefit would be only local unless the whole river were improved to give at least 4 feet navigation to Camden the year round, for Ouachita River is not navigable to Camden by the smallest boats in extreme low water, there being as little as 16 inches on the bars in Black River, the stretch from the Four Rivers at Trinity to Red River, to say nothing of the rock and gravel bars in the river from Trinity to Camden, the head of navigation. The people interested in Arkadelphia naturally desire that the upper river shall be improved if possible, and think it unfair that their views should not be accepted without demur. Complaint was made that the work in the upper river had not been well done, and I therefore had the river examined at the lowest stage, and am satisfied that everything contemplated and estimated for has been accomplished; that is, the removal of leaning timber, drift, and the most dangerous snags to give a reasonably safe navigation during high stages. More can not be done upon a stream that is subject to sudden rises of as much as 10 feet in a day and that ranges between high and low water not less than 40 feet at Camden. I do not know the exact difference of elevation between low water at Arkadelphia and at Camden, but as the slope is not less than four-tenths foot at Camden, it can not be less than 30 feet, and yet with this great fall and a current of from 1.5 to 3 miles per hour, and in high floods much greater, the low-water discharge will not vary much from 350 cubic feet a second, which would give a channel 4 feet deep and not over 30 feet wide, provided the velocity could be kept under 3 feet per second, or say 2 miles per hour.

The report on the Mississippi delta survey (Humphreys and Abbot), page 26, edition of 1876, says:

Few rivers differ more in the quantity of water at different seasons than the Ouachita. Flowing from a hilly or mountainous tract more constancy might be expected in the column of water; but though the places drained by the Little Missouri and Fourche au Cado are not deficient in springs, yet the extensive region toward the sources of Ouachita has little water except what is supplied by rains in the winter and spring. When the parching heat of summer has dried the country above the mouth of the Little Missouri the Ouachita becomes very low as far south as the head of Black River.

(Arkadelphia to Trinity is about 370 miles.)

To show other opinions in regard to the river above Camden held by people engaged in navigating Ouachita between Camden and New Orleans, attention is invited to the complaint of December 27, 1889, made to the Secretary of War and referred to me for report, the body of which is as follows:

We, steamboatmen who have been navigating this river (Ouachita) for the past 30 years from New Orleans to Camden, Ark., beg to call your attention to the manner in which the river improvement of Ouachita has been managed. The gentleman,

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Captain Davis, now in charge, informs us that his instructions are to work now on the river from Camden above. There is no steamboat business nor navigation above Camden. No boats for several years have been running there, and the money expended there is of no benefit to steamboats or commerce. The river from Camden down is in very bad condition, as Captain Davis knows, and requires his attention, there being very many snags and obstructions in the channel. Captain Davis knows the best and most economical method to remove these obstructions, which should be done at once. We do not know to whom we should apply unless to you, asking you to give Captain Davis instructions to work from Camden down. Our season for steamboating is short, and we ask as a special favor that you will refer the matter to the proper person for prompt action, and oblige us especially.

I reported the work done on the river below Camden, and that the work above Camden was not discretionary, but required by the law of August 11, 1888, appropriating \$9,000 for that purpose, also that in March, 1887, with 18 feet on the gauge at Camden, the pilot of the snag boat *Wagner*, 30 inches draft, refused to take the responsibility of going above Camden bridge on account of the danger of being caught above, as the river was falling, although I did not contemplate using the boat more than two days inspecting the upper river.

There is but one way in which the question of improving the river between Arkadelphia and Camden can be settled, and that is by an accurate survey, especially in the line of levels. I have said that the difference of elevation between low water at each place was not known, but it may be estimated by combining the results of river and railroad surveys in Ouachita Valley. The Iron Mountain Railroad levels gave a difference between the bridges at Little Rock and Arkadelphia of about 71 feet, and placed the bridge at Fulton on Red River at the same height as that at Little Rock. I connected the latter with the Coast Survey precise bench, and the former with the levels of Red River survey, and found a discrepancy of less than 1 foot. The precise levels from Mississippi River to Shreveport included high and low water marks at Monroe on Ouachita, and one bench of the survey of 1871 from Trinity to Camden. The survey of 1873 from Camden to Trinity gave a discrepancy in levels of about 6 feet as compared with those of 1871, but the several common benches at and near Monroe show a constant difference in reference planes, so that, assuming them to agree and referring all elevations to the common datum of the Commission surveys, the variation at either end of the river line may be taken as not greater than 5 feet. With these conditions high water at Arkadelphia will be about 63 meters (say 207.5 feet), Cairo datum; at Camden, 41.4 meters (say 136 feet), and at Monroe 30.7 meters (say 101 feet).

The profile of 1873 shows a rise and fall at Camden of 12.3 meters (40.3 feet), so that if the same range is assumed low water at Arkadelphia would be 51 meters (167.2 feet) Cairo datum. The distance between the two stations has been estimated from 72 to 100 miles, giving a fall of from 9 inches to 1 foot to the mile.

But the chief tributary of that part of Ouachita (Little Missouri) enters some 50 miles below Arkadelphia, and therefore, and from the rapidity with which the river rises and falls at Camden, it is evident that the range at Arkadelphia must be very much less than at Camden. The estimate made some years ago of 30 feet at Arkadelphia is probably about right, which would give the low-water elevation at that point at about 53 meters (say between 175 and 180 feet) Cairo datum, giving a total low-water fall of from 80 to 85 feet, or, say, from 10 to 16 inches to the mile. Making all due allowance for errors in the levels, it is probable that the average slopes of either high or low water between Arkadelphia and Camden can not be less than 6 inches to the mile, so that

improvement by jetties, wing dams, or dredging would not be practicable.

Increase of depth by any of these means from Camden upward would cause the low-water limit to fall, and thus reduce the present depths on the shoals above, breaking the assumed low-water line into a line of successive pools and rapids. Open navigation at medium and lower stages could not be obtained by dredging, except by excavating to such a depth as to reduce the low-water slope to, or less than, that at Camden. On the other hand, slack-water navigation would not be of any material benefit to Arkadelphia unless low-water navigation were first obtained by some plan for the general improvement of the whole river below Camden. To give a navigable depth of 3 feet from Camden to Arkadelphia, supposing that the water supply should be sufficient, would require not less than three dams and locks above Camden, and probably six or seven, with maximum lifts safe for such foundations as are presumed to exist. But, as already said, the feasibility of this or of any permanent improvement of upper Ouachita can not be judged without a survey.

The first thing requisite is the determination of the high and low water elevations at Arkadelphia and Camden, and the most economical method of doing so would be to run a line of precise levels from the Coast and Geodetic Survey benches from Little Rock to Arkadelphia, 65 miles along the Iron Mountain Railroad, thence along the branch roads to Gurdon and Camden, 50 miles, and thence return to close at Pine Bluff, Arkansas River, along the Cotton Belt route, 64 miles.

If the elevations at Arkadelphia and Camden should prove to be much less than those I have given, the survey of the upper river might be undertaken, connecting stations along the river by ordinary levels. If the railroad companies which would be benefited by the levels along their lines should be willing to help, as the Vicksburg, Shreveport and Pacific Railroad Company did on the line across Louisiana to Red River, the precise levels suggested above could be finished in about 3 months for \$5,000. These lines would be essential to an accurate survey of Ouachita River from Camden to Red River, so that, if that should be authorized, the cost would be borne by the general appropriation by fixing Arkadelphia as the upper limit.

The survey of the river and valley from Arkadelphia to Camden, a very difficult country, with the height of both banks determined by ordinary levels, and transvalley sections made at intervals to ascertain the amount of land subject to overflow, would cost about \$160 the mile, or about \$12,000, in addition to the precise levels, necessary in any case, on the basis of 75 miles length of upper river.

Attention is invited to the map of Ouachita Valley and the plate showing the approximate limits of high and low water on Ouachita, and to the subject of improving the river from Camden to Red River in my report of this date upon Ouachita and Black Rivers. I recommend that no further appropriation be made for Ouachita above Camden until it shall be shown by a proper survey that permanent improvement of the upper river is practical at a reasonable cost.

Money statement.

July 1, 1890, balance unexpended.....	\$2, 400. 74
June 30, 1891, amount expended during fiscal year	2, 400. 74

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COMMERCIAL STATISTICS.

In the past fiscal year there was navigation for small boats from Camden to Arkansas from the middle of December until the latter part of May, and for larger boats during high stages say from January to May.

The boats which ran above Camden were as follows:

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Round trips.	Between what places.
						Light.	Loaded.		
Caddo	Stern-wheel steamboat.	40.16	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>in.</i>	<i>in.</i>	Camden and mouth Little Missouri River. New Orleans and mouth Little Missouri River. Do.
H. M. Townsend	do	89.70	116.7	18.0	3.1	0	8	1	
Prince	do	107.88	120.0	25.0	2.8	2	0	4	

The freights reported were as follows:

	Tons.
Cotton	150
Staves	5,205
Grain	44
Miscellaneous	200
Total down freights	5,599
Return freights	3,732
Total freights	9,331
Estimated value, in round numbers	\$130,000

V 5.

IMPROVEMENT OF BAYOU D'ARBONNE, LOUISIANA.

Bayou D'Arbonne is formed by the junction of the South, Middle, and North or Corney Branches, near Farmerville, Union Parish, northern Louisiana; flows in a southeasterly direction, and enters Ouachita River 6 miles above Monroe, La. The course of the bayou is very tortuous, through an alluvial bottom varying in width from 1 mile at the head of navigation to 5 or 6 miles at its mouth, which is overflowed during high water to a depth of from 5 to 15 feet. In its windings the stream touches the hills, at several places, which serve as shipping points for the country back of them.

An examination and a survey were made in 1883, and the project for improvement was based upon the latter. The bayou is navigable only at high stages, and it was believed that by the removal of snags, logs, wrecks, and leaning timber from Stein Bluff on the Corney Branch, to the mouth of the bayou, 42½ miles, the boating season would be lengthened two months and navigation made less hazardous at all times. The estimated cost of such improvement was \$15,000, if spent in two consecutive seasons. (Report Chief of Engineers, 1884, pages 1372-1381).

The following appropriations have been made:

By act of—	
July 5, 1884	\$5,000
August 5, 1886	2,000
August 11, 1888	2,000
September 19, 1890	2,000
Total amount appropriated to June 30, 1891	11,000

Operations commenced in 1884, and were continued in 1886, 1887, and 1889, extending over the bayou from its mouth to Stein Bluff. During this period the improvement from Stein to Harris Bluff, or Shiloh Landing, 13 miles above, was undertaken by private subscription, and in 1890 boats ran to the latter point for 6 months. Considerable work was done by steamboat men in the way of clearing leaning timber and removing the worst snags before the improvement was undertaken by the United States, and in 1883, the year the survey was made, the bayou was reported as navigable from 6 to 7 months of the year. The work done by the United States extended the period of navigation fully one month, enabled boats of double the capacity of those formerly used to trade in the stream to advantage and with less risk, shortened the time for making trips, and reduced freight rates one-half.

During the fiscal year 1891 operations were as follows:

The stream having been reported much obstructed by fallen timber, and as it was desired to clear it out if possible before the high-water season set in, a flatboat was repaired and fitted up for quarters of a chopping party the latter part of December, and towed from Monroe, La., to the junction of D'Arbonne and Corney Forks January 5-6. A party of 20 men commenced work the following day at Stein Bluff, but rainy weather set in soon after, and by January 15 the water had risen so much that it became advisable to suspend operations. The work had been carried downstream about 9 miles, and consisted of destroying trees and stumps in the channel by means of high explosives, pulling snags, felling and girdling the timber along the banks, and cutting up all logs liable to be carried into the stream and become obstructions, the following being a summary of what was done:

Snags removed	33
Stumps removed	19
Shore snags cut	143
Logs cut	422
Trees removed	219
Trees girdled	342

The boat and outfit were laid up at Moselys Bluff to await a lower stage, but continued heavy rains prevented any work, and after they had ceased backwater from the Ouachita kept the bayou up. As there was no prospect of being able to resume work till late in the summer, at the beginning of May the boat was transferred to Bayou Bartholomew, where operations would not be affected by backwater from the main river.

The available balance will be expended during low water this summer or fall in continuing the work begun in January.

The steamer *Tributary* (94 tons) burned in this bayou last season on the first trip, with 233 bales of cotton, and the steamer *Lake Washington* (96 tons) burned on the third trip. The wrecks of these vessels will be removed if found to obstruct navigation.

The work is not permanent, as new obstructions are added from time to time, but it can be done so thoroughly as not to require attention for some years if the balance of the original estimate is granted by the next appropriation, although this estimate was made for two consecutive seasons' work.

Money statement.

Amount appropriated by act approved September 19, 1890.....	\$2,000.00
June 30, 1891, amount expended during fiscal year.....	1,109.49
July 1, 1891, balance unexpended	<u>890.51</u>

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{ Amount (estimated) required for completion of existing project.....	\$4,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	4,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

In the past fiscal year this bayou was navigable for nearly 8 months, from October until the latter part of May, inclusive. The boats employed in this trade were as follows:

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Round trips.	Between what places.	Number of passengers.
						Light.	Loaded.			
Josie W	Stern-wheel steamboat.	156.40	140.9	30.4	4.8	2	6	6	5	Monroe and Stein Bluff, La. 20
Lake Washington	do	96.39	102.0	24.0	4.3	2	0	6	0	do 10
Sallie	do	68.25	109.0	23.9	3.3	1	0	3	0	18 Monroe and Shiloh Landing, La. 45
Tributary	do	93.78	83.0	18.6	3.0	1	2	3	2	do 1
Addie	do	12.54							18	do 18

The freights reported were as follows:

	1890-'01.	1889-'90.	1888-'89.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Cotton	2,738	1,500	2,500
Cotton seed	500	1,000	
Hides	4		5
Lumber	9,000	10,250	
Miscellaneous	543		
Total down freights	12,785	12,750	2,505
Return freights	1,187	1,066	1,070
Total freights	13,972	14,416	4,175
Estimated value in round numbers	\$983,500	\$646,000	\$500,600

The bayou is the only available means of transporting crops and supplies, except by hauling long distances in wagons to Monroe or to the Vicksburg, Shreveport and Pacific Railroad on the south.

V 6.

IMPROVEMENT OF BAYOU BARTHOLOMEW, LOUISIANA AND ARKANSAS.

This stream rises in southeastern Arkansas within a few miles of Pine Bluff, and, following a tortuous course, flows at first nearly parallel to Arkansas River, at a distance varying from 15 to 30 miles; then parallel to the Mississippi, at about the same average distance, but after entering Louisiana turns to the southwest and finally enters Ouachita River opposite Ouachita City. The total drainage area of the bayou and its tributaries is about 1,800 square miles. The States of Louisiana and Arkansas made expenditures at various times for its improvement,

navigation in it having been carried on to a considerable extent as early as 1843.

Examinations were made by the United States in 1872, 1879, 1880, and 1884. (Reports Chief of Engineers, 1872, pages 383-386; 1879, pages 997-1003; 1881, pages 1453-1457; and 1885, pages 1548-1552.) The project was adopted in 1881 and contemplates the removal of snags, logs, wrecks, leaning timber, etc., obstructing navigation from Baxter, Ark., to the mouth. This part of the bayou was estimated to be 213 miles long, but from measurements of the maps at this office the distance appears to be about 150 miles. New obstructions are added every year, hence no estimate for permanent improvement is given.

The following appropriations have been made:

By act of—

March 3, 1881	\$8, 000
August 2, 1882	5, 000
July 5, 1884	5, 000
August 5, 1886	5, 000
August 11, 1888	5, 000
September 19, 1890	5, 000

Total amount appropriated	33, 000
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The work commenced in 1881, and was continued in 1882, 1884, 1886-'87, and 1889-'90; operations extended over nearly the entire portion of the bayou included in the project and benefited navigation to a great extent, but at no time were the funds available sufficient to go over the entire stretch thoroughly, as contemplated in the original project, which contained estimates for two consecutive seasons' work during low water at a cost of \$26,862. Before the improvement commenced three months was the average duration of the navigable season; in 1890 it was reported that there was better navigation for 6 months; that boats of double the capacity made trips with greater safety in half the time; and that the rates of freight had been reduced 50 per cent.

During the fiscal year 1890-'91 operations were continued as follows:

The quarter-boat and outfit were dropped down from Mosely Bluff on Bayou D'Arbonne to Monroe, La., May 1 and 2, where supplies were received and a chopping party organized. May 6 to 10 the quarter-boat was towed to Portland, Ark., where operations commenced May 11, and were continued downstream to the Hughes Place, La., estimated to be about 50 miles. The work consisted of girdling trees near the banks, cutting leaning timber, stumps, shore snags, and logs on the banks, and removing snags, logs, stumps, and trees from the channel by the use of high explosives and blocks and tackle.

Overseer Watkins Decker, under whose supervision the work was done, reports as follows:

The removal of large trees that had caved into the bayou and fallen across the channel will permit boats to navigate at from a 3 to 4 foot less stage of water. The clearing of timber from the points and bends, and widening narrow places, will enable steamboats to make better time, and the destruction of dangerous shore snags and stumps, that have been a menace to steamboat men in past years, will lessen the danger of navigation greatly.

The planters along the bayou are much interested in its improvement, in order that they may have steamboat competition with the Houston, Central Arkansas and Northern Railroad, which runs nearly parallel to the bayou, and they informed me that as soon as navigation stops the railroad raises freight rates 25 per cent. On both banks of the bayou are fertile farms, producing thousands of bales of cotton yearly, and it requires large quantities of supplies for the labor employed on these plantations. The roads, over which a portion of the crop has to be hauled before navigation opens, run through swamps, and are nearly impassable in wet weather;

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hence the advantage to the planters to have better navigation, and for a longer period, in order to ship their crops and receive supplies by water near their gins.

The banks are heavily timbered, and it will be impossible to clear in one season all the trees that should be cut, and snags will appear from year to year, but as the improvement progresses the work will be lighter and the annual expense of keeping the bayou open to navigation will be less and less.

The following is a summary of the work reported:

Snags removed from channel	1, 670
Stumps removed from channel and banks.....	1, 199
Shore snags removed.....	2, 124
Logs removed from channel and banks.....	7, 529
Leaning trees removed	20, 296
Trees girdled.....	24, 432

This work will be continued downstream as long as there are funds available, but at the present rate of progress the appropriation will be expended by the middle of August.

It would be of great advantage to the shipping interest to have gauges at convenient points, as at Baxter or Portland, Ark., on the Missouri Pacific system, to inform steamboat men when they could enter the stream and the depths they could carry on the shoals. These stations are but 14 and 28 miles from the Coast Survey precise bench at McGehee, Ark., and would require only 31 miles of leveling to connect them with the Cairo datum. With a gauge at the mouth of Ouachita River, the approximate limits of high and low water could be determined in one season, and the probable depths at low water taken from soundings while removing obstructions. The cost of this work is insignificant compared with the information and benefits that would result. Other points might be reached by a line of levels down the Houston, Central Arkansas and Northern Railroad to Monroe, La., but the line would not be essential except for a survey of the bayou in connection with the improvement of Ouachita River. The cost of establishing two gauges, leveling, and wages for observers would fall within \$500. No separate estimate is made for this work, as it would properly be chargeable to the improvement of the stream.

Money statement.

July 1, 1890, balance unexpended.....	\$4. 90
Amount appropriated by act approved September 19, 1890.....	5, 000. 00
	<hr/>
	5, 004. 90
June 30, 1891, amount expended during fiscal year.....	2, 758. 34
	<hr/>
July 1, 1891, balance unexpended.....	2, 246. 56
July 1, 1891, outstanding liabilities.....	347. 60
	<hr/>
July 1, 1891, balance available.....	1, 898. 96
	<hr/>
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	10, 000. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Navigation in this bayou opened to McCombs Landing, Arkansas, at mouth of Bear House Creek, December 15, 1890, and closed May 1, 1891, on account of obstructions. Low-water navigation was continued to Point Pleasant, La., until June 15.

The following list shows the steamboats engaged in this trade during the fiscal year:

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.			Between what places.	Number of passengers.
						Light.	Loaded.	Round trips.		
Joale W	Stern-wheel steamboat.	156.40	140.9	30.4	4.8	2	6	6 15	Monroe to Poplar Bluff, Ark.	100
Lake Washington	do	96.39	102.0	24.0	4.3	2	0	6 0 4	Monroe to Lind Grove, La.	10
Sterling White ..	Side-wheel steamboat.	117.09	120.0	30.5	4.2	2	0	4 6 21	Monroe to Bear House Creek.	65
Sallie	Stern-wheel steamboat.	68.25	109.0	23.9	3.3	1	2	4 0 ..	Not reported.	

The commerce of the stream was reported to be as follows:

	1890-'91.	1889-'90.	1888-'89.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Cotton	3,971	2,000	530
Cotton seed	2,467	4,000	431
Lumber	20,080	11,839	(*)
Staves	17,822		(*)
Cotton-seed meal	516		(*)
Cypress shingles	20		(*)
Miscellaneous	1,320		(*)
Total down freight	46,196	17,839	(*)
Return freight	3,103	4,000	(*)
Total freights	49,299	21,839	(*)
Estimated value, in round numbers	\$826,000	\$492,700	(*)

* Incomplete.

This stream is crossed at Baxter, Ark., the upper limit of the improvement, by a branch of the St. Louis, Iron Mountain and Southern Railroad, which connects with the Mississippi River at Arkansas City and runs west 56 miles to Warren, Ark., and will be extended to Camden, on the Ouachita, which is connected with the main line by a branch to Gurdon, Ark. The Houston, Central Arkansas and Northern Railroad (another branch of the Missouri Pacific system) runs parallel to Bartholomew from McGehee, Ark., to Monroe, La. The projected extension of the New Orleans and Northwestern Railway north of Rayville, La., will cross Bayou Bartholomew on a line from Bastrop, La., to Hamburg, Ark.

V 7.

IMPROVEMENT OF BAYOU BOEUF (BOEUF RIVER), LOUISIANA.

Bayou Boeuf, usually called Boeuf River, has its source in Chicot County, southeastern Arkansas, flows in a general southwesterly direction, and enters Ouachita River at Stafford's Point, 8 miles above Harrisonburg, La. The improvement of this stream was undertaken by the State of Louisiana half a century ago, the report of the board of public works of 1840 stating that it had been opened to Point Jefferson.

An examination was made by the United States in 1880 (pages 1424-1428, Report Chief of Engineers, 1881), and the project based thereon contemplates removing snags, logs, and leaning timber obstructing

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navigation at high stages from Wallace Landing to the mouth. The distance between these points was estimated to be about 280 miles, but as scaled from the maps it appears to be only 152 miles.

In 1884 an examination of three outlets near Point Jefferson was made, in accordance with requirements of the river and harbor act of that year, and their closure was recommended as necessary to preserve navigation in the stream. (Report Chief of Engineers, 1885, pages 1545-1548.)

New obstructions are added every year, and require removal from time to time, hence no estimate for permanent improvement is made.

The appropriations have been as follows:

By act of—

March 3, 1881	\$5,000
August 2, 1882	5,000
July 5, 1884	5,000
August 5, 1886	5,000
August 11, 1888	6,000
September 19, 1890	5,000

Total amount appropriated..... 31,000

The removal of obstructions was commenced in 1881, and continued in 1882, 1884, and 1888-'89, and enabled steamboats to run to Point Jefferson, 19 miles below Wallace, during high stages, with greater safety.

The estimates of 1884 for closing the outlets amounted to \$8,500, but no appropriation was made for that purpose until August 5, 1886, when \$5,000 was provided for "continuing improvement and for closing outlet No. 1." Upon re-examination it was found essential that all the outlets be closed, and, by uniting with the planters whose lands would be protected, this was done in 1887 and 1888. Outlet No. 1 was closed substantially, the second was closed by a heavy dam at a lower elevation, and the third by a low dam, this being all the work that could be done with insufficient appropriations assisted by private subscription. The closure of the outlets gave immediate benefit to navigation by confining the flow to the natural direction and scouring the bars below, but during the overflow from the Mississippi River in the spring of 1890 the dams were destroyed.

Owing to lack of funds it was impracticable to make any examination of the outlets in the fiscal year 1890, after the dams were destroyed, but during low water last October, Assistant Engineer John Ewens visited the locality and reported as follows:

I found the three outlets open and the dike that separates Bayous Big and Little Bonne Idee gone. Outlet No. 1, closed in 1887, was found in a more critical condition than outlets Nos. 2 and 3, closed in 1888. Of outlet No. 1, just enough of the old embankment was left to define its outline at each end, about half of the opening was dry, and the remaining portion was from 4 to 5 feet deep, and dead water. Outlet No. 2 was completely dry at base of the old dike; the top of the ground at the base was not less than 4 feet above the water. About one-fifth of the old embankment is standing, with both ends well defined. The old levee at both terminals of this dike was washed out at several places. The dike at outlet No. 3, with the exception of a small depression about 3 feet wide through the center, was dry at the base and above the water about 6 feet, with both ends well defined. From the above it will be seen that the scour when the dike gave way was at its maximum below and not at the dike sites, thus saving a considerable yardage of earth and leaving a good foundation to work on should the outlets be closed during the coming season. The dike between Big and Little Bonne Idee bayous was cut by some miscreant during the recent high water, and I found a large force, with mules and scrapers, closing the opening. Mr. A. Hefner is supervising and doing the work at his own expense. The closure of this opening is very important, as it keeps the flood water from the breaks in Possum Fork Levee and from Lake Chicot from inundating the highly cultivated lands in this vicinity. It also turns the whole volume of Big Bonne Idee into its own channel, which, if the outlets are closed, will be very beneficial to

Bœuf River, on account of increased volume and current, causing it to deepen at the shoals below Point Jefferson.

The effects of the outlets at Point Jefferson on Bœuf River and contiguous cultivated lands are in no way commensurable with the small amount required to close them. Their effect on the river is to deflect it from its course and dispel its swift-flowing waters into an interminable swamp, which serves as a drainage basin for the cultivated lands contiguous to it; and the river, thus robbed of its channel-making force, shoals and forms drift traps below the outlets, destroying navigation and the flood-water capacity of the stream for over 30 miles. The closing of any one of these outlets will in no manner subserve the improvement, as the closure of all three will alone accomplish the end desired.

Estimates.

Outlet No. 1, 18,000 cubic yards at 25 cents	\$4,500
Outlet No. 2, 8,000 cubic yards at 20 cents	1,600
Outlet No. 3, 16,000 cubic yards at 20 cents	3,200
Inspection	200
	<hr/> 9,500

In connection with the above it is to be borne in mind that the work is isolated and limited in extent, and that it will be more difficult to obtain earth now than when the first closure was made, and at outlet No. 1 it will be hardest to procure. The estimates include extensions to join the levees and the usual percentage for shrinkage, 20 per cent. With fair weather all the outlets could be closed in 30 days.

The last appropriation provided \$5,000 for "continuing improvement," a sum too small to attempt the closure of the outlets without assistance from the people interested, and for this reason it was recommended that if the parish levee board and the owners of adjacent lands would join in and help complete the work the entire appropriation be applied to that purpose. This was approved, and I wrote to the president of the parish police jury October 11, and to a prominent planter of that locality November 12, inquiring whether the parish and the people to be benefited by the work would subscribe sufficient money to make up the amount needed to close all three outlets substantially. To the first of these letters I received no reply, but the answer to the latter stated that as the parish consisted of ten wards, only one of which was affected by overflow, the police jury refused to make any appropriation; that the president of the State Levee Board had been seen and it was feared that there would be no help from that source, and that little or nothing could be obtained by individual subscription.

The appropriation became available so late in the season that it was not thought economical to begin any work until the winter and spring floods should be over, and the water has remained so high this season that it will be best to wait until the coming low water. For the reasons stated herein, and because the amount on hand is not sufficient to close all of the outlets, it is proposed to apply the available balance after July 1, 1891, to removing obstructions, snags, and leaning trees, and to put off building the dams until an appropriation shall be made for the purpose.

The openings will enlarge somewhat, but it is not expected that there will be any excessive scour through them, so that the estimates of Assistant Engineer Ewens will not require much increase. I recommend a single appropriation of \$20,000, of which \$12,000, or so much thereof as may be found necessary, may be applied to closing all three outlets substantially and connecting them with the parish levees, applying the remainder to continuing the work of clearing the banks and removing logs from the channel. As the expense of organizing, cost of tools and outfit and administration will be about the same for an appropriation of \$5,000 as for \$20,000 on a stream of this kind, a large appropriation can be employed far more economically than a small one.

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Information in regard to the slope of the stream can not be given for lack of proper surveys. We have but one section determined with any degree of accuracy. This is at the bridge of the Vicksburg and Shreveport Railroad, near Girard, La., where both the railroad company and the Signal Service have kept gauges for several years. The zero of the Signal Service gauge is nearly the low water of 1884, but the high-water mark is not known. This zero is about 32.25 feet below the top of the rail at the drawbridge across Bœuf River, and corresponds to 72.2 feet on the railroad company's datum, and to 72.45 feet above the Cairo datum. As the danger line is given at 25 feet and the general elevation of the banks is about 30 feet above zero, and the neighboring lands are completely flooded in high water, it is presumed that extreme high water will reach at least 30 feet on the gauge, or 102.45 feet Cairo datum. The New Orleans and Northwestern Railroad Company, in applying for approval of plans for a bridge across Bœuf River, about 2 miles north of Rayville, gave about the same elevation (102.75 feet above Cairo datum) for the high water of 1882. There is nothing definite known in regard to elevations north of these points; the transvalley section made for railway purposes in 1850, and given on the map of the Delta Survey, showing an elevation of about 11 feet greater some 30 miles above. Approximate high water on the Ouachita at the mouth of Bœuf River, about 100 miles below Girard, is 87 feet, and low water 33 feet above Cairo datum, giving a high-water fall of about 16 feet and a low-water fall of nearly 40 feet in 100 miles. These approximate figures show that at medium and high stages Bœuf River could be navigated without difficulty if the leaning trees were removed, and that at low stages a slack-water system on Ouachita River might back up Bœuf River for about 30 miles. Should a survey of the Ouachita be undertaken it might be necessary to include Bœuf River, at least as far as Girard, to determine the water supply and the area that might be overflowed; and from the information so obtained the feasibility of extending the system by one or two locks and dams could be determined at comparatively small cost. Fortunately the levels can be run with considerable ease over the railroad lines projected and in operation, so that the chief expense on this account would be in the topographical and transvalley lines. As part of the general plan for the survey of the whole Ouachita Valley it is probable that \$6,000 would be sufficient for the basin of Bayou Bœuf. Upon this understanding, then, the following estimate is submitted for the fiscal year ending June 30, 1893:

For closing 3 outlets near Point Jefferson, Morehouse Parish.....	\$12, 000
For removing obstructions between Wallace Landing and Ouachita River..	8, 000
For survey of Bayou Bœuf in connection with the survey of Ouachita River	6, 000
Total	26, 000

Money statement.

July 1, 1890, balance unexpended	\$22. 09
Amount appropriated by act approved September 19, 1890	5, 000. 00
	5, 022. 09
June 30, 1891, amount expended during fiscal year	50. 77
July 1, 1891, balance unexpended	4, 971. 32
July 1, 1891, outstanding liabilities	22. 00
July 1, 1891, balance available	4, 949. 32

{ Amount that can be profitably expended in fiscal year ending June 30, 1893 26, 000. 00
 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

In the past fiscal year this river was reported navigable from December until May, inclusive.

List of steamboats engaged in navigation during the year.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Round trips.	Between what places.	Number of passengers.
						Light.	Loaded.			
Era No. 10.....	Stern-wheel steamboat.	176.89	138.0	30.8	5.0	2	0	5	1 New Orleans and Point Jefferson, La. 2 New Orleans and Daugherties, La. 10 New Orleans and Eason Ferry, La.	44
Hibernia.....	do	157.06	135.0	25.0	4.0				1 New Orleans and stave camps.	
Irwin.....	Tug	3.00				2	2	2	Staffords Point and Prairie Landing, 5 miles above.	75

Summary of freights reported.

	1890-'91.	1889-'90.	1888-'89.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Cotton	1,760	1,397	1,084
Cotton seed	716	781	884
Staves	1,777	263	54
Miscellaneous	179		91
Total down freights	4,432	2,391	2,063
Return freights	3,458	1,594	1,376
Total freights	7,890	3,985	3,439
Estimated value, in round numbers	\$636,500	\$580,850	\$457,100

The Vicksburg, Shreveport and Pacific Railroad crosses Bœuf River near Girard, La., and the projected line of the New Orleans and Northwestern Railway will cross about 1½ miles north of Rayville, La. The Houston, Central Arkansas and Northern Railroad runs parallel to the river on the west, and a new line is projected (Louisiana, Arkansas and Missouri Railroad) which will touch the river at several points on the east.

V 8.

IMPROVEMENT OF TENSAS RIVER AND BAYOU MAÇON, LOUISIANA.

Tensas River has its source in Lake Providence, in northeastern Louisiana, within 2 miles of the Mississippi River, flows in a general southerly direction, gradually diverging from the Mississippi, and joins Onachita and Little rivers at Trinity, La., in forming Black River. Bayou Maçon was united under the same head of appropriation with Tensas River by the act of 1884. This stream rises in Desha County, southeastern Arkansas, near the source of Bœuf River and a few miles west of the Mississippi, flows in a general southerly direction west of and nearly parallel to the Tensas, and enters the latter about 40 miles above its mouth.

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Examinations were made in 1880, upon which the plan of improvement is based. The project contemplates removing snags, logs, and leaning timber obstructing navigation; in Tensas River, from Dallas, La., to its mouth, at an estimated cost of \$23,000; and in Bayou Maçon, from Floyd, La., to its mouth, at an estimated cost of \$17,000. (Report Chief of Engineers, 1881, pages 1457-1467.) The estimates were based on calculations for continuous work in one low-water season, and, in view of the appropriations for the improvement, are without value, as new obstructions are added from time to time. The distance from Dallas to the mouth of Tensas has been estimated to about 180 miles, but by scaling from the best maps of the stream in this office it appears to be 134 miles; and the distance from Floyd, on the Maçon, to Tensas River, obtained in the same manner, is 98 miles instead of 130.

The following appropriations have been made:

By act of—

March 3, 1881	\$3, 000
July 5, 1884	4, 000
August 5, 1886	4, 000
August 11, 1888	5, 000
September 19, 1890	5, 000

Total amount appropriated.....	21, 000
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The total amount expended to June 30, 1890, was \$15,873.24; of which \$7,529.25 was applied to improving Tensas and \$8,343.99 to the Maçon. The obstructions were removed as far as practicable with these amounts. The principal steamboat traffic is between New Orleans and Floyd, and at the close of operations in 1889 the master of the largest boat then running in that trade reported that the work had shortened the time of trips 12 hours.

Owing to the late appropriation and high stages of water during the greater portion of the time since, no work was done during the fiscal year ending June 30, 1891. It is intended to commence operations as soon as practicable, and it is probable that the entire amount available will be expended before winter.

Two steamboats have been sunk in these streams this season, the *H. J. Dickey*, 208 tons, in Bayou Maçon, and the *Danube*, 232 tons, in Tensas River. The latter has been raised, but the former is a wreck. The underwriters were given a reasonable time to save cargo and machinery, and the hull will be destroyed with dynamite when operations are resumed.

Gauges should be established on both of these streams on the line of the Vicksburg and Shreveport Railroad, both to ascertain their rise and fall and to give information to steamboat men. The cost of the service should not exceed \$200 a year for each.

The alteration of the bridge of the New Orleans and Northwestern Railway at Daniels Ferry, on Tensas River, has not been completed. High water throughout the year is given as the reason for the delay; but while the fact can not be disputed, it is well understood that the company is unable to go on. If the piling is not removed when the work of improvement reaches Daniels Ferry, it will be blasted or pulled out.

A gauge at the bridge would be useful, and it is probable that when the company is reorganized the bridge tender will be required to take observations. The gauge could be put up and set to Cairo datum at a cost of about \$20.

Money statement.

July 1, 1890, balance unexpended.....	\$126. 76
Amount appropriated by act approved September 19, 1890.....	5, 000. 00
July 1, 1891, balance unexpended.....	5, 126. 76
July 1, 1891, outstanding liabilities.....	.28
July 1, 1891, balance available.....	5, 126. 48
{ Amount (estimated) required for completion of existing project.....	19, 000. 00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	10, 000. 00
{ Submitted in compliance with the requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

These streams were navigable the entire year.

List of steamboats engaged in navigation of Tensas and Maçon during fiscal year 1891.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Round trips.	Between what places.	Number of passengers.
						Light.	Loaded.			
H. J. Dickey.....	Stern wheel steamboat.	208.54	187.0	36.0	6.0	3	0	7	0	5
Danube.....	do	282.32	175.0	33.8	5.1	1	8	4	0	10
H. W. Graves.....	do	81.22	94.6	17.6	3.0	1	2	3	0	45
Marcus Collins.....	do	48.14	90.0	17.0	2.5	1	0	3	0	45
L. Teal.....	do	27.52	82.0	12.2	2.0	1	2	3	0	45
Marco.....	do	43.90	104.3	19.0	2.6	.....	.....	.....	.....	.....
W. H. Cherry.....	do	396.07	189.0	32.0	5.2	.....	.....	.....	.....	.....
									New Orleans, La., and landings on Tensas and Maçon.	225
									Trinity, La., and the Cut-off, 16 miles above the mouth of Maçon.	
									Connecting boats up per Maçon.	

Summary of commerce reported.

Freights.	1890-'91.	1889-'90.	1888-'89.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Cotton.....	2, 760	1, 527	2, 750
Cotton seed.....	4, 850	2, 920	4, 000
Hides and skins.....	10	2	5
Live stock.....	6	.....	225
Staves.....	1, 032	3, 325	3, 500
Miscellaneous.....	378	50	1, 823
Total down freights.....	9, 026	7, 824	12, 308
Return freights.....	6, 000	5, 216	8, 202
Total freights.....	15, 086	13, 040	20, 505
Estimated value in round numbers.....	\$999, 500	\$742, 390	\$1, 194, 100

The Vicksburg, Shreveport and Pacific Railroad crosses Bayou Maçon near Delhi, La., and Tensas River at Dallas, La. The New Orleans and Northwestern Railroad crosses Tensas River near Daniels Ferry, Concordia Parish, La.

V 9.

IMPROVEMENT OF BAYOUS RONDEWAY AND VIDAL, LOUISIANA.

Bayous Rondeway and Vidal form a drainage canal for the low lands between the Tensas and Mississippi rivers in the vicinity of Lake Palmyra, an old channel of the Mississippi around Davis Island, 23 miles below Vicksburg, cut off in 1867. Bayou Rondeway joins Tensas River near Dallas, La., and, tending in a general southeasterly direction, was connected artificially with Lake Palmyra about 8 miles from its entrance into the Mississippi by a cut known as Harpers Canal. From this point, tending in a southeasterly direction, the name is changed to Bayou Vidal, which forms a connection with the Tensas through Mill Bayou.

In accordance with the river and harbor act of August 2, 1882, an examination of these streams was made in 1882, and in view of the cost of the work and the small amount of commerce to be benefited the officer in charge reported adversely on their improvement. (Report Chief of Engineers, 1884, pages 1347-1351.)

Further examination was required by river and harbor act of August 5, 1886, and was made in the spring of 1887, when it was learned that the State of Louisiana intended building a new levee, which would cut off these bayous entirely from the Mississippi, and they would receive water from the Tensas only when it was high and run dry in low water. It was recommended, however, that \$1,000 be expended in removing obstructions, chiefly leaning trees, from the canal and that part of Bayou Vidal remaining open between Lake Palmyra and the line of levee north of the lake. (Report Chief of Engineers, 1887, pages 1497-1498.)

The river and harbor act of August 11, 1888, appropriated \$1,000 for this purpose which was expended during the fiscal year 1889 in carrying out the project. After completion of the work the canal was claimed as private property, and the owner issued notice that toll would be collected on freights passing through. This canal or cut was made, before the old levee system along the west shore of the bend broke down, to connect Bayou Vidal with Lake Palmyra for the purpose of draining the swamp above, and of late years has been used for the navigable route from the lake into the bayou, the old line of the bayou having become obstructed by fallen timber and stumps. In my annual report for 1889 I recommended reopening the old bayou to save the steamboat interest from the imposition of the tolls exacted. The act of September 19, 1890, appropriated \$1,000 for this purpose.

The work can be done at low water only, and for this reason was deferred until the Mississippi reached a low stage. Operations were commenced June 22, 1891, by the chopping party transferred from Big Black River, and continued until the end of the year, at which time 394 leaning trees had been cut.

Money statement.

Amount appropriated by act approved September 19, 1890.....	\$1,000.00
June 30, 1891, amount expended during fiscal year	116.02
July 1, 1891, balance unexpended	883.98
July 1, 1891, outstanding liabilities .....	.69
July 1, 1891, balance available	883.29

COMMERCIAL STATISTICS.

Lake Palmyra is navigable for small boats to New Carthage, at mouth of Bayou Vidal, except at lowest stages of the Mississippi. During high water these boats run into Bayou Vidal to Kouns Landing.

List of stern-wheel steamboats engaged in navigation.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Round trips.	Between what places.	Number of passengers.
					Light.	Loaded.			
T. P. Leathers*	458.6	209.2	38.0	7.2	Ft. in.	Ft. in.		Not reported.	
Laura Lee	377.9	208.0	37.4	6.1	3 0	8 0	10	Bayous Rondeway and Vidal and New Orleans.	
Dyersburg	73.08	93.0	18.4	3.0	1 6	3 0	42	Vicksburg, Miss., and New Carthage, La., and into Bayou Vidal to Kouns Landing.	384
L. H. Sargent	85.46	116.2	22.4	4.3	1 10	3 0	97	do	1,289

* Steamer *Leathers* burned in November, 1890, and all records of business were lost.

Summary of commerce reported.

Freights.	1890-'91.	1888-'89.
	Tons.	Tons.
Cotton	1,978	1,750
Cotton seed	1,684	6,000
Live stock	65	
Lumber	428	1,000
Provisions	1,112	1,400
Grain	1,369	400
Miscellaneous	822	81
Total freight	7,459	10,631
Estimated value, in round numbers	\$392,950	\$750,000

If information had been complete, the commerce of the past year probably would have been as much, if not greater than that of fiscal year 1889.

V 10.

IMPROVEMENT OF BIG BLACK RIVER, MISSISSIPPI.

This stream rises in Webster County, Miss., flows in a general south-westerly direction and enters Mississippi River at Grand Gulf, 37 miles below Vicksburg, having a length estimated to be about 400 miles.

An examination was made by the United States in 1881 (pages 1565-1570, Report Chief of Engineers, 1882), and the project contemplated clearing a channel suitable for navigation at high stages by the removal of snags, logs, wrecks, leaning timber, etc., from Cox's Ferry to the mouth, about 130 miles, at an estimated cost of \$32,000.

The following appropriations have been made:

By act of—	
July 5, 1884	\$5,000
August 5, 1886	5,000

The first of these appropriations was expended in 1884-'85, when a chopping party removed the principal obstructions for a distance of

about 75 miles above the mouth. The act of 1886 required that no part of the appropriation should be used until the State of Mississippi caused the bridges south of the Vicksburg and Meridian Railroad to be so constructed as not to obstruct navigation. The bridges referred to were the Louisville, New Orleans, and Texas Railway Bridge, about 15 miles above the mouth; a county bridge at Ivanhoe Ferry, about 50 miles above the mouth; and a county bridge at Baldwin Ferry, about 70 miles above the mouth. The fixed railway bridge was changed to a swing bridge in 1889, in accordance with an act of the State legislature, the Ivanhoe Bridge has been replaced by a ferry, and the only one remaining to obstruct navigation is that at the crossing called Baldwin Ferry, about 25 miles by river below the Vicksburg and Meridian Railroad Bridge.

The river and harbor act of September 19, 1890, removed the restriction contained in the act of 1886 and authorized the expenditure of the appropriation. The project was modified to include only the portion of the river below the Baldwin Ferry Bridge to the mouth, and operations during the fiscal year were as follows:

The United States snag boat *Hooker* was brought from Monroe, La., for use on this work, and a barge purchased at Vicksburg and fitted up for quarters of a chopping party, and the *Hooker*, with the barge in tow, entered Big Black January 24. The river from the mouth to the Louisville, New Orleans and Texas Railway Bridge was in good condition; above the bridge to Ivanhoe Ferry there was considerable leaning timber, and from Ivanhoe to Fisher Ferry it was impossible, at places, for the steamer to pass until large, overhanging trees were cut. Fisher Ferry was reached January 27, and as it was found impracticable for the snag boat to proceed further, the chopping party commenced work above that point. Finding that the *Hooker* could be used to advantage no longer, it was returned to Vicksburg and laid up February 7. The chopping party continued upstream until February 28, when work was stopped by high water. By the end of March the water had fallen sufficiently to resume operations, and the chopping party was reorganized and the boat worked upstream to Baldwin Ferry Bridge. From there the work was carried downstream to a short distance below the Ivanhoe Ferry, and as the funds were getting low it was decided early in June to apply the available balance to getting the quarter-boat out of the river and breaking up jams of drift on the way. The boat reached the mouth of the river June 18, and was towed to the mouth of Bayou Vidal, La., June 20, for use on the improvement of that stream. Cutting leaning timber was the principal work done, as the stream is navigable at high stages only, and then there is sufficient depth over the logs in the channel. Sand-bars and gravel beds are too extensive and numerous to justify their removal to permit the passage of the smallest boats at low stages. The stretch of river worked over during the past year, from the Baldwin Bridge to Ivanhoe Ferry, was the most obstructed, as but little work had been done on it under the former appropriation. The following is a summary of the work reported:

Snags and logs removed from channel	101
Jams removed	27
Side jams removed	115
Drift piles removed	2
Leaning trees cut	13, 403
Brush wing-dams built	1

It is difficult to form an opinion as to what benefits, if any, will be derived from continuing the improvement of this stream. At present the business consists chiefly of saw logs rafted out of the river and ~~trucks~~ brought down in barges, with occasional trips of very small

steamers. It is stated, however, that prior to the building of railroads large quantities of cotton and produce were shipped out of the river in flat and keel boats.

While the river is within a short distance of Vicksburg, and the entire portion on which any improvement is contemplated at present is in Warren County, it is accessible only at three or four points, and over very bad roads in wet weather, and practically is without mail facilities. For these reasons the cost of getting supplies, and of inspection and superintendence, are increased very considerably, and it is recommended that if any further work be done the appropriation be sufficient to complete all that is required in one low-water season. The expenditure of \$10,000 would clear the banks thoroughly from the Baldwin Bridge to the mouth, after which further work should not be required until the amount of commerce is sufficient to justify a more extensive improvement by the removal of obstructions in the channel.

Money statement.

July 1, 1890, balance unexpended	\$5,000.00
June 30, 1891, amount expended during fiscal year	4,735.23
July 1, 1891, balance unexpended	264.77
July 1, 1891, outstanding liabilities	20.96
July 1, 1891, balance available	243.81
<hr/>	
{ Amount (estimated) required for completion of existing project	10,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	10,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

This stream is navigable for small boats at high stages only. The business is inconsiderable, consisting chiefly of rafting saw logs and towing staves in flat boats.

List of steamboats engaged in navigation of Big Black River for fiscal year 1891:

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.			Round trips.	Between what places.
						Light.	Loaded.			
L. H. Sargent	Stern-wheel steamer.	85.46	116.2	22.4	4.3	1	10	3	0	1 Vicksburg and Fishers Ferry.
J. B. O'Brien	Tug	44.49	70.8							2 Trips for rafts; no information regarding terminus of trips.
Little Joe	Tug									No report.

Summary of commerce reported, 1890-'91.

Cotton	Tons
Cotton seed	13
Lumber	11
Staves	2
Provisions	471
Grain	22
Saw logs	10
	9,449
Total freights	9,978
Estimated value in round numbers	\$72,000

The Alabama and Vicksburg Railway crosses Big Black, on a fixed bridge, 13 miles east of Vicksburg. The Louisville, New Orleans and Texas Railway crosses, on a swing bridge, about 15 miles above the mouth.

V II.

IMPROVEMENT OF YAZOO RIVER, MISSISSIPPI.

Yazoo River, about 173 miles long, is formed by the junction of Tallahatchee and Yallahusha rivers in Le Flore County, Miss., flows in a general southerly and then southwesterly direction, and enters Mississippi River 5 miles above Vicksburg.

An examination of wrecks of gunboats, steamers, and other obstructions placed in the river during the war was made by the United States in 1873 (pages 483, 484, Report Chief of Engineers, 1873), and a further examination was made in 1874 (pages 364-367, Report Chief of Engineers, 1874). The project contemplates the removal of wrecks, logs, snags, and leaning timber which obstruct navigation throughout the entire length of the river. New obstructions caused by floods, sliding banks, etc., are brought into the river every year, and no estimates have been made for permanent improvement on this account.

The following appropriations have been made:

By act of—	
March 3, 1873	\$40, 000
March 3, 1875	12, 000
August 14, 1876	15, 000
June 18, 1878	25, 000
March 3, 1879	15, 000
June 14, 1880	12, 000
March 3, 1881	6, 000
August 2, 1882	8, 000
July 5, 1884	10, 000
August 5, 1886	15, 000
August 11, 1888	32, 000
September 19, 1890	25, 000
Total amount appropriated	215, 000

The wrecks of nine steamboats, sunk during the war, were removed by contract in 1873-'74. Experience gained by this work showed that the improvement could be continued more economically by means of a snag boat operated with hired labor, and in 1875 and 1877 the United States snag boat *O. G. Wagner* was employed in removing wrecks and other obstructions. In 1879 the snag boat *John R. Meigs* was completed, and the principal work since has been done with that boat. The amount expended to June 30, 1890, was \$186,875.13.

In the fiscal year ending June 30, 1891, operations were as follows:

GENERAL IMPROVEMENT.

Owing to lack of funds for general improvement of the river, operations had to be deferred until after the act of September 19, 1890. After some minor repairs, the United States snag boat *Meigs*, P. R. Starr master, left Vicksburg October 20, and entered Yazoo River and commenced the removal of obstructions, consisting mainly of tree slides. Work was carried up to the mouth of Tallahatchee, which was reached October 31. During November the boat was employed in Tallahatchee River, but returned to Yazoo in December, and was brought to Vicksburg December 2. Some minor repairs were made, and the boat returned to work December 7. Col. C. B. Comstock, Division Engineer, and myself, accompanied by Assistant Engineer Ewens, made a trip of inspection as far as Linden, 11 miles above Yazoo City, and thence back to Yazoo City, where we left the boat December 8. The *Meigs* con-

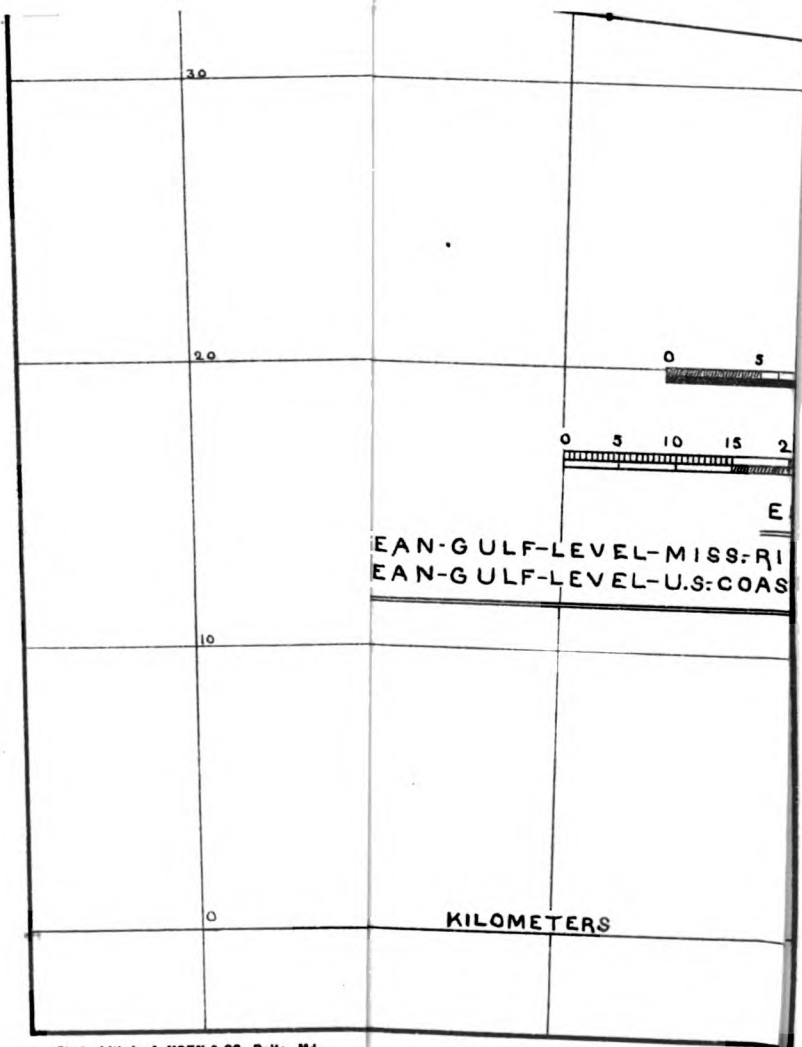


Photo-Lith. by A. HOEN & CO., Balto., Md.

tinned up the river, removing obstructions, arrived at the mouth of Tchula Lake December 10, and was employed in that stream until the 20th. Returning to Yazoo December 21, the boat commenced work on the river side of Honey Island and continued upstream to Just Over, which was reached December 24. By that time the river had begun to rise rapidly, and the boat turned back, breaking side jams and cutting leaning trees on the way down, and reached Vicksburg December 30.

Continued high water from January until the latter part of May prevented any work.

Under authority of the Chief of Engineers the *Meigs* was transferred April 1 to Captain Townsend, Corps of Engineers, for use on levee work in the Third District, Mississippi River, and was returned to this district May 5.

On the 2d of June the *Meigs* resumed operations in Yazoo River and continued upstream until June 15, when it entered Tallahatchee, and was employed until June 20. Heavy rains caused both rivers to rise at this time, and as the work could not be continued to advantage the *Meigs* returned to Vicksburg and laid up June 25 to await a lower stage.

The following is a summary of the work done by the *Meigs* in Yazoo River during the year:

Snags pulled.....	307
Stumps pulled.....	31
Logs removed from channel.....	65
Side jams removed.....	10
Shore snags cut.....	16
Leaning trees cut.....	633
Trees girdled.....	84

The snag boat *Meigs* is in good order so far as the hull, machinery, and cabin are concerned, but a new iron deck is needed around the boilers where a wooden deck was put it when the boat was built, and an iron deck aft the main engines in the space used for blacksmith shop. The cost of this work is estimated at \$1,200. New boilers will be required within 2 years, the cost of which, including taking down the old casings, pipe work, and covering, is estimated at \$2,500.

The *Meigs* is too large to be used economically for chopping parties and bank work alone, and therefore for general use in Yazoo and tributary streams I recommend a flatboat about 75 feet by 22 feet by 4 feet, with steam capstan or hoisting engine, and crane or shears, and a deck house to accommodate a party of about 20 men. The estimate for the boat, machinery, tools, rigging, and outfit is \$3,000, and for 4 months' service is \$4,000.

The hull of the pumping dredge has rotted so much that the seams can not be kept calked tight, and as there is no place near by where the boat could be hauled out for repair, it will be most economical to build a new hull. An appropriation of \$2,500 is recommended for this purpose.

To give a clear idea of the extent of country drained by Yazoo and its tributaries, and the amount of navigable water ways impaired by the bar at the mouth of the system, I submit a map of Yazoo Basin and a sheet giving the limits of high and low waters in Yazoo River, derived from the best information attainable without an extended survey. The map shows a high-water navigation of over 1,200 kilometers (800 miles), which could be increased to 1,600 kilometers (1,000 miles) by a comparatively small outlay; and it is probable that a low-water navigation of at least 600 kilometers (400 miles) could be maintained if the entrance to Mississippi River were open and free. This hydrograph is very remarkable. It shows at once that Yazoo River must have a moderate and uniform slope at all stages, and that even in extreme floods the cur-

rent can never attain destructive speed, thus emphasizing the statement in former reports that Yazoo is an ideal stream. With a permanent navigable entrance to Mississippi River, cheap transportation could be had the year round for a large part of this system, extending into Tallahatchee, Big Sunflower, Tchula Lake, and Yallabusha River. It is safe to say that no expensive works, such as locks and dams, training walls, or dikes, will ever be needed in Yazoo River, and that but little revetment will be required. The channel is uniform in section and banks generally above overflow, except from Mississippi River if the levees should break, danger from which is diminishing year by year. Increased security from floods and improved facilities for moving crops and getting supplies are drawing planters and small farmers from the hill counties and beyond into this fertile valley, and railroads are penetrating it in all directions to compete for the growing trade. Liberal appropriations for 2 or 3 years to permit systematic clearing of the banks and removing logs from the tributary channels would stimulate the settling of the valley and bring large returns to the people in keeping freight rates within reasonable bounds.

The maps and hydrographs will be corrected and amended from time to time as more definite information is obtained. The bottom of the river and the limits for bottom chords of bridges, that may be required as the valley develops, should be determined and referred to the same datum plane. For these objects, and as a part of a general plan for improving Yazoo River, a system of gauges should be established at the principal towns and the mouths of the large tributaries, eventually forming an extension of the water gauges on Mississippi River and tributaries established by joint resolution of February, 1871. Such gauges would be of immediate value in time of flood to the people living in the valley, and of special value to the interests of navigation, enabling steamboat men to load their boats at low water so as to avoid detentions at the shoals. By connecting the gauges with the Cairo datum value would be given to a mass of information in regard to flood heights, discharge, etc., of former years. The principal cost of the work would be in the leveling and establishing the gauges, bulletins, and permanent monuments. The estimates for the fiscal year are \$1,500 for establishing the gauges and bulletins and pay of observers, and \$3,500 for leveling between stations and permanent monuments.

SURVEY OF YAZOO RIVER FROM THE LOUISVILLE, NEW ORLEANS, AND TEXAS RAILWAY BRIDGE TO ITS MOUTH.

PROGRESS REPORT.

The item of appropriation by act of September 19, 1890, contained an allotment of \$5,000 to "be used in making a survey of the Yazoo River from the bridge of the Louisville, New Orleans, and Texas Railway to its mouth, for the purpose of determining in what manner the mouth of the river can be so improved as to freely permit the passage through the same at all seasons of the year of vessels engaged in the navigation of the river; and said survey shall also include an investigation into the feasibility and advantages of making a new mouth or outlet for said river by way of Chickasaw Bayou, or otherwise, together with an estimate of the cost of the same."

A party was organized under Assistant Engineer H. M. Marshall as soon as practicable after the approval of the project required by law, and work began in the field October 29, and continued until December

6, when high water compelled suspension of operations. The rivers have remained too high since then to allow the completion of the field work, especially at the mouth, and work will not be resumed until Mississippi River shall have fallen to a stage below 20 metres Cairo datum, or about 10 feet on the Vicksburg (Kleinston) gauge.

The delay in getting the information at the mouth of the river specifically required by the act, and which involves not over a week's work on topography and soundings, prevents any discussion of the problem, but it is hoped that the river will fall early in the season, so that a special report may be submitted in time for the action of the river and harbor committee. The maps are finished, except the last sheet, and the latter and the notes of levels, cross sections, and profiles are in shape for plotting.

The cost of the survey required the full amount of the allotment without the borings contemplated in the project, and as they will be necessary for the purpose of final estimates, it is to be regretted that the full amount of the estimate, \$8,000, was not given for the survey.

If it should appear feasible to divert Yazoo River through Chickasaw Bayou, Thompson Lake, or through a canal on a shorter line, it will be important to know the character of the bottom along these lines to a depth of from 20 to 50 feet, the sum of \$2,500 is recommended for the purpose. Reproducing the maps and sections on a suitable scale for working drawings will require \$500.

DETAILED ESTIMATES FOR FISCAL YEAR 1893.

Snag boat <i>Meigs</i>—	
Five months' service	\$12,500
Seven months in ordinary	1,800
New iron decks	1,200
New steel boilers	2,500
Flatboat with steam-power	3,000
Four months' service	4,000
New hull for pumping dredge	2,500
Three months' work with same	1,500
Establishing and maintaining gauges	1,500
Expenses of leveling, monuments, etc	3,500
Borings and examinations in connection with survey of Lower Yazoo River	2,500
Reproducing maps of survey	500
Office expenses, incidental repairs, tools, outfit, and contingencies	3,000
	40,000

Money statement.

July 1, 1890, balance unexpended	\$3,124.87
Amount appropriated by act approved September 19, 1890	25,000.00
	28,124.87
June 30, 1891, amount expended during fiscal year	14,780.90
	13,343.97
July 1, 1891, balance unexpended	13,343.97
July 1, 1891, outstanding liabilities	23.69
	13,320.28
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	40,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867	

The amounts expended during the fiscal year were:

For general improvement, care of plant, etc	\$9,811.32
For pumping dredge boat	327.27
For survey below Louisiana, New Orleans and Texas Railroad Bridge ..	4,642.31
Total	14,780.90

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COMMERCIAL STATISTICS.

Navigation of Yazoo River from head to mouth was uninterrupted in the past fiscal year.

List of boats that navigated Yazoo River in fiscal year 1891.

Name.	Tonnage.	Length.	Breadth.	Depth.	Drafts.		Round trips.	Between what places.	Number of passengers.
					Light.	Loaded.			
Addie E. Faison*.....	241.50	Feet. 135.0	Ft. 30.0	Ft. 4.9	Ft. 2	Ft. 2	5	35 Vicksburg and head of Yazoo River.	850
Blanks Cornwell*.....	232.40	140.0	29.0	4.6	2	4	5	27 do.....	805
Birdie Bailey*.....	109.74	111.0	22.0	3.5	1	10	4	158 Yazoo City and Belzona.....	3,100
R. L. Cobb*.....	204.56	145.1	28.5	3.0	1	8	4	1 Vicksburg and head of Yazoo River.	
Lake City*.....	35.80	75.0	16.6	4.6	1	4	3	20 Yazoo City and mouth Sunflower River.	485
Crown Point*.....	159.14	123.0	25.0	4.2	2	2	4	4 3 Vicksburg and Greenwood.....	46
Ike Bonham*.....	78.52	93.4	18.0	3.6	1	8	3	6 81 Yazoo City and mouth Sunflower River.	755
Hill City*.....	90.00	95.0	22.0	4.5	1	6	4	0 { 20 Vicksburg and Yazoo City.....	
J. B. O'Brien (tug).....								1 Vicksburg and Sartatia.....	
								1 Natchez and Anthony's Ferry...	

* Stern-wheel steamboats.

Summary of commerce reported.

Articles.	1890-'91.
Cotton.....	Tons. 13,750
Cotton seed.....	12,500
Hides and skins.....	10
Live stock.....	60
Lumber.....	3,600
Staves.....	1,350
Provisions.....	9,020
Grain.....	11,080
Saw logs.....	2,140
Miscellaneous.....	10,540
Total freights for Yazoo proper.....	64,050
To which should be added the commerce of Tallahatchee River, Tchula Lake, Big Sunflower River, and Steele Bayou, which was brought out through Yazoo River.....	97,538
Total weight, Yazoo River and tributaries.....	161,638
Estimated value, in round numbers.....	\$6,315,275

In the fiscal year 1890 the commerce reported for Yazoo River and tributaries amounted to 63,653 tons. With the lumber and timber rafted added, this should have been increased to 81,423 tons.

The Georgia Pacific Division of the Richmond and Danville Railroad crosses Yazoo River at Fort Loring, 5 miles from Greenwood, and the Louisville, New Orleans and Texas Railway crosses about 15 miles above the mouth. The latter road has a branch from Clarksdale to Minter City on the Tallahatchee, which will be extended down the stream to Greenwood. The Yazoo Branch of the Illinois Central Railroad, from Parsons on the Yallahusha to Jackson, Miss., runs parallel to the river, touching at Greenwood, Sidon, Tchula, and Yazoo City, and has a tap line from Tchula to the main line at Durant.

V 12.

IMPROVEMENT OF TCHULA LAKE, MISSISSIPPI.

The east and narrowest channel of Yazoo River where it divides in passing Honey Island is called Tchula Lake or River. It lies wholly within Holmes County, Miss., and is about 60 miles long. Honey Island is about 100 miles above the mouth of Yazoo River, and fertile plantations join one another along its banks, their estimated annual product being about 20,000 bales of cotton.

The regular Yazoo and Tallahatchee steamboats make trips through the lake when the water is high enough. An examination of Tchula Lake was made by the United States in 1879, and the principal obstructions to navigation were found to be snags and logs in the lower part and leaning timber and shore snags along both banks from the foot to the head of the island. (Report Chief of Engineers, 1880, pages 1350, 1351.) The project contemplated removal of these obstructions to permit light-draft boats to enter the lake earlier in the season. The estimated cost was \$10,000, if all the work should be done in one low-water season.

The appropriations have been as follows:

By act of—	
March 3, 1881	\$3,000
August 2, 1882	2,500
July 5, 1884	1,500
August 5, 1886	2,000
August 11, 1888	3,000
September 19, 1890	3,000
Total amount appropriated	15,000

Work was commenced in 1881 and continued in 1882, 1884, 1886, 1887, and 1889, and the obstructions were removed as far as practicable with the amounts appropriated.

Operations in the fiscal year 1891 were as follows:

The United States snag boat *John R. Meigs*, P. R. Starr master, entered the mouth of the lake December 10 and worked up to the head, removing snags, tree slides, and all the heavier obstructions. On the way back the most obstructive brush and leaning trees were cut until the water rose too high for continuing such work to advantage. The snag boat left the lake December 20 and resumed operations in Yazoo River the next day.

The following is a summary of the work:

Snags pulled	58
Stumps pulled	1
Logs removed from channel	11
Side jams removed	3
Leaning trees cut	884
Trees girdled	196
Square yards willows and brush cut	660

The principal work now needed is the clearing of trees and brush from the banks. The brush has grown so rapidly and to such an extent that in many places the clear channel scarcely exceeds 50 feet in width, and while this growth may not be very dangerous to navigation at present, it impedes passing vessels and catches drift and should be removed thoroughly as soon as possible. This work can be done to advantage at low stages only, and it is intended to put a chopping party in the lake

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as soon as there is a reasonable prospect of continued low water, and it is probable, that the balance available will be expended before fall.

The work is of such nature that it must be gone over to remove the obstructions that are added from time to time, but by the expenditure of \$6,000 in one low-water season they can be removed so thoroughly that nothing further will be needed for several years.

Money statement.

July 1, 1890, balance unexpended.....	\$1, 721. 43
Amount appropriated by act approved September 19, 1890	3, 000. 00
	<hr/> 4, 721. 43
June 30, 1891, amount expended during fiscal year	1, 135. 20
	<hr/> 3, 586. 23
July 1, 1891, balance unexpended.....	6, 000. 00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	
{ Submitted in compliance with requirements of sections 2 of river and	
{ harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

When the water is high enough Yazoo River steamboats run through the lake.

List of steamboats that navigated Tchula Lake in fiscal year 1891.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Num-ber of passen-gers.	Number of round trips made and be-tween what places.
					Light.	Loaded.		
Stern-wheel steamboats—		<i>Fect.</i>	<i>Fect.</i>	<i>Fect.</i>	<i>Ft. In.</i>	<i>Ft. In.</i>		
Addie E. Faison	241. 5	135. 0	30. 6	4. 9	2 2	5 0	70	10, through the lake.
Blanks Cornwell.....	252. 4	140. 0	29. 0	4. 6	2 2½	5 2	110	16, through the lake.

Summary of commerce reported.

Articles.	1890-'91.
	<i>Tons.</i>
Cotton	1, 500
Cotton seed	2, 100
Live stock	27
Lumber	1, 230
Staves	3, 615
Provisions	500
Grain	900
Miscellaneous	700
Total freight	10, 272
Estimated value, in round numbers	\$492, 000

The Yazoo branch of the Illinois Central Railroad, from Parsons, on the Yallabusha, to Jackson, Miss., runs parallel to the lake, and also has a tap line from Tchula to the main line at Durant, and has diverted a large amount of the business formerly done by steamboats.

V 13.

IMPROVEMENT OF TALLAHATCHEE RIVER, MISSISSIPPI.

The head waters of this river are in Tippah County, in northern Mississippi, whence it flows in a general southwesterly direction through the counties of Union, La Fayette, Panola, joins Coldwater River in Quitman, and then, as the main stream flows, in a southerly direction through Tallahatchee and Le Flore counties, and unites with Yallabusha in forming Yazoo River.

An examination was made by the United States in 1879 (pages 982-986, Report Chief of Engineers, 1879). The project based thereon contemplated the removal of snags, sunken logs, and leaning timber obstructing low-water navigation below the mouth of Coldwater, and the wreck of the steamer *Star of the West*, 8 miles above the mouth, at an estimated cost of \$40,000. An additional examination was made in 1880 (pages 1322-1323, Report Chief of Engineers, 1880).

The following appropriations have been made for this work:

By act of—	
March 3, 1879	\$6,000
June 14, 1880	9,000
March 3, 1881	3,000
August 2, 1882	3,000
July 5, 1884	3,000
August 5, 1886	3,500
August 11, 1888	5,000
September 19, 1890	5,000
Total amount appropriated	\$7,500

Work was begun in 1879, and continued in 1880, 1881, 1882, 1884, 1886, 1887, and 1889. Parts of the appropriations of 1880 and 1881, and all of that for 1882 (a total of \$10,000), were expended on the Little Tallahatchee above the mouth of Coldwater to Batesville, as required by the acts, but this part of the stream was not included in the original project or estimate of cost. To the end of the fiscal year 1890 all other work was confined to the river below Sharkey Landing, and resulted in the removal of a large number of obstructions, to the great benefit of navigation. Before the improvement commenced the river was navigable about 6 months of the year; boats now run to Sharkey the year round, the only serious detention being at the mouth of Yazoo River.

In the past fiscal year operations were as follows:

While the original project for this stream contemplated work up to the junction of the Little Tallahatchee and Coldwater, little or nothing has been done above Sharkey, since 1882, for the reason that steamboats did not go above that landing except to make occasional trips into Coldwater River during high stages, when navigation was as good and about as safe as in the lower part of the stream. In the last year the steamboatmen asked that snagging operations be extended above Sharkey to the forks, to enable them to bring out freights from the Coldwater and Little Tallahatchee.

The snag boat *Meigs*, P. R. Starr master, entered this river November 1 and worked rapidly up to Sharkey Landing, removing only the worst obstructions on the way, as it was desired to work up to the mouth of Coldwater River before the water should fall. The boat reached a point about 6 miles above Sharkey November 7, but found the water too low to go further, and turned back and was employed on the 40 miles below Sharkey until November 17. On the later date a

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slight rise commenced and the boat was enabled to go above Sharkey, and was employed between that point and Mead Landing, at mouth of Tillatoba River, about 25 miles above, until November 25. During the remainder of November the boat worked in the lower part of the river, and then returned to the Yazoo.

Owing to continued high water nothing further was done until June 15, when the *Meigs*, which had been working in the Yazoo, entered this stream and worked for 6 days, removing tree slides, etc., after which the boat returned to Vicksburg, as the water was too high for work in the channel.

The following is a summary of the work done during the year:

Snags pulled	241	Side jams removed	1
Stumps pulled	61	Leaning trees cut	2,902
Shore snags cut	417	Trees girdled	202
Logs removed from channel	53	Square yards willows cut	95

The small amounts appropriated have prevented thorough work on this river. Major Benyaud, in submitting the project for its improvement, estimated that it would take two seasons' work at a cost of \$40,000 (page 985, Report Chief of Engineers, 1879). As stated in my last report, the snag boat *Meigs* should be used a short time each year to remove heavy snags, tree slides, and sunken logs, but the appropriation should be large enough to permit the systematic clearing of the banks by chopping parties, and \$10,000 can be expended to advantage in the fiscal year 1893.

Money statement.

Amount appropriated by act approved September 19, 1890.....	\$5,000.00
June 30, 1891, amount expended during fiscal year	2,968.98
July 1, 1891, balance unexpended.....	2,031.02
{ Amount (estimated) required for completion of existing project	12,500.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	10,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

This river was navigable to Sharkey Landing the entire year. During high stages boats ran to Mead Landing at mouth of Tillatoba Creek, and occasionally into Coldwater River.

List of stern-wheel steamboats that navigated Tallahatchee River in fiscal year 1891.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Round trips.	Between what places.	Number of passengers.
					Light.	Loaded.			
		Feet.	Ft.	Ft.	Ft. in.	Ft. in.			
Addie E. Faison.....	241.50	135.0	30.6	4.9	2	2 5 0	3	Vicksburg and Belen, Miss	250
							5	Vicksburg and Mead, Miss	
							27	Vicksburg and Sharkey, Miss	380
Blanks Cornwell.....	232.40	140.0	29.0	4.6	2	4 5 2	3	Vicksburg and Mead, Miss	
							27	Vicksburg and Belen, Miss	700
							1	Vicksburg and Sharkey, Miss	
John F. Allen	133.90	130.2	24.0	4.2	1	8 4 0	15	Vicksburg and Belen, Miss	700
							70	Vicksburg and Mead, Miss	
R. L. Cobb	204.56	145.1	28.5	3.0	1	8 4 4	1	Vicksburg and Sharkey, Miss	
D. C. Fogel	89.09	121.9	21.0	4.4			1	do	
Maggie Itaney	148.62	128.5	25.0	4.5			1	New Orleans and Coldwater, Miss	
								do	

Summary of commerce reported.

Articles.	1890-'91.
	<i>Tons.</i>
Cotton.....	4,000
Cotton seed.....	6,000
Hides and skins.....	5
Live stock.....	32
Lumber.....	1,424
Staves.....	9,245
Provisions.....	4,200
Grain.....	4,800
Saw logs.....	18,000
Miscellaneous.....	5,000
Total freights.....	53,708
Estimated value, in round numbers.....	\$2,115,000

The Louisville, New Orleans and Texas Railway has a branch line from Clarkdale to Minter City on the Tallahatchee, which will be extended to connect with the Georgia Pacific near Greenwood; and the Georgia Pacific and Illinois Central Railroads, at Greenwood, are competitors for the trade of Tallahatchee River.

V 14.

IMPROVEMENT OF STEELE BAYOU AND WASHINGTON BAYOU, MISSISSIPPI.

Steele Bayou has its source in Swan Lake, in Washington County, Miss.; flows in a general southerly direction, forming the outlet for Lake Washington, with which it is connected by Washington Bayou, and enters Yazoo River about 12 miles above its mouth. Its course is parallel to the Mississippi River, and its length about 85 miles; the fall is very slight, and generally the stream is not navigable, except when the Mississippi is high enough to fill the lower portion with back water.

An examination was made by the United States in 1883, and the officer in charge reported adversely to the improvement. (Report Chief of Engineers, 1884, pages 1360-1362.)

The following appropriations have been made, viz:

By act of:	
July 5, 1884.....	\$2,500
August 5, 1886.....	2,500
August 11, 1888.....	2,500
September 19, 1890.....	2,500
Total amount appropriated.....	10,000

The project under which work has been done contemplates removing snags, stumps, drift, and leaning timber to improve high-water navigation. Chopping parties were employed in 1884-'85 and the latter part of 1886, and in February and July, 1889, small steamers were hired to go over the work and remove the heavier obstructions. Operations extended from the head of Washington Bayou to the mouth of Steele Bayou, but were by no means thorough, on account of the small appropriations.

In the fiscal year 1891 operations were as follows:

The United States snag boat *Thos. B. Florence*, J. H. Lewis master, was sent into this stream February 8, and worked until the end of that

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month. Operations extended over the lower 50 miles of the bayou, between the foot of Poindexter Island and the mouth, and the following work was done:

Snags removed from channel	87	Side jams removed	35
Jams removed	7	Leaning trees cut	38

High water in the Mississippi, which continued until late in May, stopped the work. Operations had not been resumed to the end of the year, as the available plant was in use elsewhere. It is intended to apply the balance of the appropriation to continuing the removal of obstructions as soon as practicable.

The region bordering the upper part of the bayou and Washington and Swan lakes furnishes the principal products. The lower portion is subject to overflow, and not much land in the vicinity is cultivated. The west side of Lake Washington is near the Mississippi, and a loop line of the Louisville, New Orleans and Texas Railway, from Coahoma to Rolling Fork, passes between Swan Lake and Lake Washington, and has diverted the main traffic from the bayou.

Steamboat navigation in Steele Bayou was not commenced until 1879, and since the construction of the railroad it has gradually decreased until for several years the trade has amounted to little or nothing.

Much work is needed to make navigation in the bayou reasonably safe and unobstructed, and if the improvement is to be continued, it is recommended that \$5,000 be appropriated, as that amount, if spent in one low-water season, will open the bayou for high-water navigation, and further work will not be required, at least for many years.

Money statement.

Amount appropriated by act approved September 19, 1890	\$2,500.00
June 30, 1891, amount expended during fiscal year	1,520.66
July 1, 1891, balance unexpended	979.34
July 1, 1891, outstanding liabilities .....	.31
July 1, 1891, balance available	979.03
Amount (estimated) required for completion of existing project	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

This stream was navigable from January 1 to the end of May.

List of stern-wheel vessels engaged in navigation.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.			Between what places.	Number of passengers.
					Light.	Loaded.	Round trips.		
Dyersburg.....	73.08	Feet. 93.0	Feet. 18.4	Feet. 3.0	Feet. in. 1 6	Feet. in. 3 0	3	Vicksburg and Bear Garden.....	50
Josie D. Harkins.....	73.13	110.0	19.5	3.3	2 0	3 4	2	do.....	30

Commerce reported.

Articles.	1890-'91.	1889-'90.
	<i>Tons.</i>	<i>Tons.</i>
Cotton	1	8
Cotton seed	50	346
Lumber (in logs)	150	
Miscellaneous	125	
Total down freights	326	354
Return freight	300	350
Total freights	626	704
Estimated value, in round numbers	\$16,000	\$50,000

The branch of the Louisville, New Orleans and Texas Railway has diverted the main traffic from this bayou.

V 15.

IMPROVEMENT OF BIG SUNFLOWER RIVER, MISSISSIPPI.

This river has its source in Moon Lake, Coahoma County, Miss., flows in a southerly direction, and enters Yazoo River about 45 miles above its mouth. During extreme high water it is navigable to Clarksdale, 280 miles above the mouth, but Faison, 144 miles above the mouth, ordinarily is considered the head of navigation.

An examination was made by the United States in 1878 (pages 982-984, Report Chief of Engineers, 1879), and the plan adopted for the improvement contemplated building timber and brush dams at the shoals to scour a channel 3 feet to 40 inches deep, and the removal of snags, sunken logs, and leaning timber obstructing navigation, at an estimated cost of \$66,000.

The following appropriations have been made:

By act of—

March 3, 1879	\$20,000
June 14, 1880	8,000
March 3, 1881	4,000
August 2, 1882	5,000
July 5, 1884	5,000
August 5, 1886	5,000
August 11, 1888	5,000
September 19, 1890	5,000

Total amount appropriated..... 57,000

Work was commenced in 1879 and continued in 1880, 1881, 1882, 1883, 1884, 1887, and 1889. Operations extended over the navigable portion of the river from Clarksdale to the mouth, but were by no means thorough on account of small appropriations, and a great deal of work is required as new obstructions are added every year. It is reported, however, that benefits have been gained by the work done as follows: Before the improvement commenced (in 1879) the river was navigable for very light boats about 6 months of the year; now it is navigable the year round, but difficult and dangerous at low stages on account of shoals, snags, and sunken logs. Larger boats are used, and make the round trip (of about 180 miles and return) in 5 days, while before the improvement it was unusual for a boat to make the trip under 8 days. Freight rates are reported to be 50 per cent. less. The lands along the river

are being cleared and settled rapidly of late years, which is attributed in part to the improved navigation.

In the fiscal year 1891 operations were as follows:

The United States snag boat *Meigs*, P. R. Starr master, was sent into this river January 10, and continued work until February 13, when it was stopped by high water. Operations extended up to Faisononia, nearly midway between Woodburn and Lehrton, and in addition to the removal of obstructions brush dams were built at head of Muscle Shoals and at Hollywood Bar. Regarding the work done and the condition of the river, the master of the *Meigs* reported as follows:

Backwater from the Mississippi made the river too high for any work below Campbellsville on the way up: Oliphant Bar had full 12 feet of water on the shoalest places. Worked up through the narrow river to "head of drift" and removed a number of large and troublesome snags. Above Mike Hughes Landing, at "head of drift" to Osceola Gin, a distance of 38 miles, the river is wide and deep, with but few snags in the channel, and all of them were in sight. At and above Osceola Gin the entire bottom appears to be covered with logs and trees; none of them were in aight, and they could be caught only with the drag chain. At places the channel is so close in shore that we had to remove leaning trees before we could get at the snags. At Osceola 17 snags were removed in a short distance; at Savage Point 33 were removed in a distance of 400 yards, and 65 were taken out at Sedan Point and Bend inside of 500 yards. Pilot Bookout says we removed nothing but what was directly in the channel, and the worst snags only. He seems to know exactly where they are, and can tell the kind of wood before they are pulled. Judging from the number we have removed, there is enough work to keep this boat employed constantly for a year.

The following is a summary of the work done by the *Meigs*, viz:

Snags and logs pulled	437	Leaning trees topped	104
Stumps pulled	9	Trees girdled	53
Side jams removed	4	Square yards willows and brush cut..	35
Shore snags cut	4	Lineal feet brush wing dams built..	375
Leaning trees cut	159		

Wrecks removed; boiler of steamer *Sarah Elliott* put on bank at Faisononia.

The river remained at a stage too high to resume work to advantage until the latter part of May, when the snag boat *Florence*, J. H. Lewis master, was fitted out, and was sent into this stream June 1, and continued work during the month. Operations extended up to the wreck of the steamer *Nellie Hudson*, 18 miles above Faisononia. As the wreck was but little in the way of navigation and the river falling rapidly, only the boiler was removed and put on the bank, and the boat proceeded downstream to avoid being caught by low water. Below Woodburn the river was too high for work in the channel, and the *Florence* returned to Vicksburg June 30.

The following is a summary of the work done:

Snags and logs removed from channel	167
Stumps removed from channel	30
Leaning trees cut	16

Wrecks removed; boiler from steamer *Nellie Hudson*.

The amounts expended during the year were:

For general improvement below Woodburn	\$3,059.62
Between Woodburn and Lehrton	1,136.45
Total	4,196.07

It is recommended that future appropriations shall not restrict expenditures to designated stretches of river, in order that the funds may be applied where the work is needed most and where it will yield the greatest benefit to navigation.

The estimate of \$66,000, made in 1879, for the improvement of this

river (page 984, Report Chief of Engineers, 1879), did not contemplate doing the work at irregular intervals extending over a period of 15 years, as it will with the usual appropriations, but was made with a view to finishing it in not more than 3 or 4 consecutive seasons. As new obstructions are added from time to time it is impossible to make any definite estimate, but if an appropriation of not less than \$20,000 is made it can be spent to advantage and with economy in 1 or 2 low-water seasons, and result in greater benefit to navigation and work of a more lasting character than a larger sum by small allotments every other year.

Money statement.

Amount appropriated by act approved September 19, 1890	\$5,000.00
June 30, 1891, amount expended during fiscal year	4,196.07
July 1, 1891, balance unexpended	803.92
July 1, 1891, outstanding liabilities	4.79
July 1, 1891, balance available	799.14
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	20,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

In the past fiscal year this river was navigable to Woodburn, about 80 miles above the mouth, the entire time, and during medium and high stages boats ran into the upper river to Faison and Burch Place.

List of stern-wheel steamboats that navigated Big Sunflower River in fiscal year 1891.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Round trips.	Round trips between what places.	Number of passengers.
					Light.	Loaded.			
		Feet.	Ft.	Ft.	Ft. in.	Ft. in.			
Josie D. Harkins	73.13	110.0	19.5	3.3	2	2 3 4	5	Vicksburg and Faison	90
							3	Vicksburg and Burch	
							7	Vicksburg and Woodburn	
John F. Allen	133.90	130.2	24.0	4.2	1	8 4 0	2	Vicksburg and Burch	50
							2	Vicksburg and Faison	
							2	Vicksburg and Woodburn	
Nellie Hudson	166.01	141.3	25.0	3.4	1	10 4 0	4	Vicksburg and Burch	186
							15	Vicksburg and Faison	
							22	Vicksburg and Woodburn	
Hill City	90.00	95.0	22.0	4.5	1	6 4 0	21	Vicksburg and Campbellsville	
Joe Seay (tug)	27.74	75.0	16.0	6.0	7	0 7 0	1	do.	

Summary of commerce reported.

Articles.	1890-'91.	1889-'90.	1888-'89.
	Tons.	Tons.	Tons.
Cotton	2,375	2,564	4,000
Cotton seed	3,500	3,975	6,000
Hides			1
Live stock	70	150	150
Saw logs	15,400	4,000	
Lumber	920	809	
Staves	3,219	5,250	490
Miscellaneous	2,027		3,880
Total down freight	27,511	16,838	14,521
Return freights	4,473	5,322	9,680
Total freights	31,984	22,160	24,201
Estimated value, in round numbers	\$945,000	\$1,240,000	\$1,858,000

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The Louisville, New Orleans and Texas Railway crosses the river at Clarksdale, and thence south runs parallel to the stream, at distances varying from 5 to 20 miles. The Georgia Pacific Division of the Richmond and Danville Railroad crosses the river near Johnsonville with a line running from Arkansas City on the Mississippi to Atlanta, Ga.

V 16.

IMPROVEMENT OF BIG HATCHEE RIVER, TENNESSEE.

This river has its source in Northern Mississippi, flows in a north-westerly and then westerly direction through the most productive region of West Tennessee, and enters the Mississippi River 50 miles above Memphis. I am informed that navigation in this stream commenced as early as 1827; that in 1841 and 1842 the State of Tennessee appropriated \$100,000 for improvement of rivers in the western part of the State, one-third of which was expended on Big Hatchee, after which considerable business was done; that from six to seven boats with capacities for carrying 500 to 1,600 bales of cotton were employed during the cotton season, and navigation was open the year round for light-draft boats. In 1866 the legislature of Tennessee declared the stream unnavigable, and authorized certain railroads to build bridges without draws, and navigation was suspended until 1879, when the law was repealed, and the bridges were altered.

An examination was made by the United States, in 1879, and the project based thereon contemplated the removal of snags, logs, leaning timber, etc., to render the stream navigable for light-draft boats from Bolivar, Tenn., to the mouth throughout the year. This part of the river was estimated to be about 240 miles long. (Report Chief of Engineers, 1880, pages 1330-1332.) The plan of operations given in the original project contemplated completing the work in *three* consecutive low-water seasons at a cost of \$30,000.

The appropriations have been as follows:

By act of—

June 14, 1880	\$10,000
March 3, 1881	3,500
August 2, 1882	3,000
July 5, 1884	2,500
August 5, 1886	3,000
August 11, 1888	5,000
September 19, 1890	5,000

Total amount appropriated (in 11 years) 32,000

In view of the above, and the fact that new obstructions are added every year, the work can not be completed within the original estimates, and small appropriations will be required from time to time to maintain unobstructed navigation.

Work was begun in 1880, and continued in 1881, 1882, 1884, 1886-'87, and 1889. Before its commencement the stream virtually was unnavigable by reason of the obstructions; in 1889 it was reported navigable for 7 months, and during the past fiscal year it was reported navigable for 9 months. The stream from Bolivar to its mouth is crossed by 4 railroads, about 60 miles apart, which transport the principal products of the country, and the main effect of the improvement so far has been to facilitate the transportation of timber and staves and prevent excessive rates of freight. The fixed bridge of the Tennessee Midland Railway, about 60 miles below Bolivar, prevents navigation of steamers above

that point. If this bridge is altered, and the natural obstructions are removed to permit boats to run the year round, so that the people may rely upon the river trade, there is every probability that steamboat navigation will be revived, though not to the extent of the period prior to the war, before the railroads were built.

The appropriation of 1890 was made late in the season, and the river has been at a stage too high for advantageous work during the greater portion of the period since, and on this account no work was done during the fiscal year 1891. It is intended to take advantage of the low-water season this summer and fall, giving special attention to the channel obstructions, which are more troublesome than leaning trees, much of the latter having been cut.

If this work is to be continued, economy will be subserved by expending in one season an amount sufficient to clear the river so that further work shall not be needed for several years. The improvement will be much more thorough and lasting by such concentration, and the practical benefit to navigation more nearly attained. I recommend the expenditure of not less than \$10,000 in one season, beginning work as soon as the stage of water will permit, constructing or hiring a flat-boat with steam capstan, and using explosives liberally for removing snags and sunken logs. A shore party, lodged in tents and moving about in skiffs, should clear the banks and supplement work in the channel. Experience in the past shows that little benefit is to be derived from small and irregular appropriations. The cost of administration is increased, and much of the good results of the work is lost during the interval between appropriations.

As a matter of history connected with the improvement of this stream and the Forked Deer River, I report that at the last session of the legislature of Tennessee an appropriation of \$5,000 was made for "surveys of a canal between the Tennessee and the Mississippi River," etc. The project for such a canal, I understand, contemplates an outlet to the Mississippi through the Big Hatchee or Forked Deer River, as may be found most feasible. After completing the surveys and selecting the most practicable route, it is intended to lay the report before Congress with a view to having the United States undertake the work of construction.

Money statement.

July 1, 1890, balance unexpended.....	\$0. 81
Amount appropriated by act approved September 19, 1890.....	5, 000. 00
July 1, 1891, balance unexpended.....	5,000. 81
July 1, 1891, outstanding liabilities.....	48
July 1, 1891, balance available.....	5, 000. 33
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{ Amount that can be profitably expended in fiscal year ending June 30, 1893	10, 000. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

This stream was reported navigable for light-draft boats between 8 and 9 months of the past fiscal year.

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List of boats engaged in navigation.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Round trips.	Between what places.	Number of passengers.
						Light.	Loaded.			
City of Charleston.	Stern-wheel steamboat.	81.32	85.0	25.0	3.7	1	6	3	Log Landing and Louisville and Nashville Railroad Bridge.	....
									Simpson and Louisville and Nashville Railroad bridge.	....
P. H. Kelly	do	45.00	90.0	18.0	2.9	1	6	3	Rialto, Van Buren, Eastmanla, and intermediate points.	....
White Oak	Tug	31.32	69.0	13.0	6.4	5	6	7	Memphis and Green Landing.	....
Ed. Durant, jr. . . .	Stern-wheel steamboat.	149.7	115.0	27.0	5.3	1	6	3	Memphis and Pilljerk.	2
									Bluff.	

Summary of commerce reported.

Articles.	1890-'91.
Cotton	Tons. 23
Lumber (saw-logs)	6,010
Staves and heading	11,600
Provisions	25
Total freights	17,658
Estimated value, in round numbers	\$184,500

The Illinois Central Railroad crosses the river at Bolivar, Tenn., the head of proposed improvement; the Tennessee Midland Railway crosses at Hatchee Station, about 17 miles from the mouth; the Louisville and Nashville Railroad crosses at Big Hatchee Station, about 117 miles from the mouth; and the Newport News and Mississippi Valley Railroad crosses at Rialto, about 57 miles from the mouth.

V 17.

IMPROVEMENT OF FORKED DEER RIVER, TENNESSEE.

Forked Deer River, 24 miles long, is formed by the junction of the North and South Forks in Dyer County, West Tennessee, about 9 miles below the town of Dyersburg, flows in a southwesterly direction, enters Obion River 4 miles above its mouth, and thus finds an outlet to the Mississippi at Hale Point, 95 miles above Memphis. Originally the mouth of Forked Deer was at Ashport, 18 miles below Hale Point, but about 52 years ago the State of Tennessee cut a canal to a bend of the Mississippi (now the mouth of Obion River), shortening the length of main Forked Deer River about one-half. The part below the canal is blocked with snags and drift, and is called "Old" and "Lost" channels. The canal is known as "Tigertail." North Fork is formed by several small creeks near Trenton, in Gibson County, flows in a westerly direction to Dyersburg, thence southwesterly. South Fork heads in

McNairy and Henderson counties and flows in a general northwesterly direction. Appropriations aggregating \$43,000 were made at various times by the State of Tennessee, but their expenditure resulted in little or no benefit to navigation.

Examinations were made by the United States in 1874, 1880, and 1887. (Reports Chief of Engineers, 1874, pages 372-380; 1881, pages 1489-1497; and 1887, pages 1494, 1495.) The projects contemplated the removal of snags, logs, leaning timber, etc., in South Fork below Jackson, North Fork below Dyersburg, and the main river. The estimates were \$19,250, \$4,500, and \$7,000 for these branches respectively, but as they were based upon plans for completing the work in one season, it is probable that the cost will be increased, as new obstructions are added from time to time.

The appropriations have been as follows:

By act of—

August 2, 1882, for South Fork	\$3, 000
July 5, 1884, for South Fork	2, 000
August 5, 1886, for South Fork	5, 000
August 11, 1888, { for South Fork	2, 500
{ for North Fork	4, 500
{ for main river	2, 500
September 19, 1890, for North Fork and main river	2, 500
Total amount appropriated	22, 000

Work in South Fork was commenced in 1883 and continued in 1884, 1886-'87, and 1888-'89. Its commerce consists chiefly of staves and lumber, brought out by flatboats and rafts of saw logs. Before the improvement commenced about one boat in three was lost by reason of the obstructions; now they make the trip with comparative safety and at less cost.

North Fork below Dyersburg was worked over in 1888-'89 and put in good navigable condition, enabling boats to run at a stage 3 feet lower than formerly.

The main stream was cleared as far as practicable in 1888-'89, but sudden rises and the limited amount prevented any material improvement to navigation.

No work was done during the fiscal year 1890-'91, as the appropriation was made late in the season, and the water has been high during the greater portion of the period since. It is intended to begin operations as soon as practicable. The party can go over the stretch from Dyersburg to the mouth of North Fork in a short time and remove any obstructions added since work was suspended in 1889, after which operations will be continued in the main stream until the funds are exhausted.

Before the railroads were built through this section of the State, some 25 or 30 years ago, there appears to have been considerable business done in this stream, but it has declined, until at the present time it amounts to little. In the past year two tugs were employed in towing rafts, lumber, etc., once in a while carrying cotton to Hale Point when the railroad freight rates got too high. South Fork is obstructed by numerous bridges, which render steamboat navigation impracticable, and there appears to be no reason or demand for its further improvement. North Fork below Dyersburg has been cleared so that it is in fairly good navigable condition; and it seems that the only work needed at present is in the main stream. With the amount available for this purpose, and an additional appropriation of \$3,000, it is believed that this work can be completed.

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Money statement.

Amount appropriated by act approved September 19, 1890	\$2,500.00
July 1, 1891, balance unexpended	2,500.00
<hr/>	
{ Amount (estimated) required for completion of existing project.....	3,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	3,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

North Fork and Main River were reported navigable in the past fiscal year from December to May, inclusive. No commerce was reported from South Fork.

List of steamboats engaged in navigation.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Number of passengers.	Number of round trips made, and between what places.
						Light.	Loaded.		
Mary Louisa*.....			<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>Ft. in.</i>	<i>Ft. in.</i>		
Peoria Belle	Tug.	31.07	70.3	12.6	4.4				
James Langhlin	Tug.	28.76	71.5	15.0	4.5	5 0	5 6	30	No report.
									75, Dyersburg on North Fork and Keno Bluff on main river (about 13 miles); 6, Dyersburg and Obion Mills on Obion River (mouth of main river).

* No report.

Summary of commerce reported.

Articles.	1890-'91.
	<i>Tons.</i>
Cotton.....	6
Cotton seed.....	25
Lumber, principally sawlogs	9,200
Staves.....	24,000
Total freight	33,231
Estimated value, in round numbers	\$250,000

South Fork is crossed at Jackson by the Illinois Central Railroad, the Mobile and Ohio Railroad, and the Tennessee Midland Railway; and by the Louisville and Nashville Railroad at Bell Depot; and the Newport News and Mississippi Valley Railroad crosses North Fork at Dyersburg.

V 18.

WATER GAUGES ON MISSISSIPPI RIVER AND ITS PRINCIPAL TRIBUTARIES.

These gauges were designed to secure information from continuous records, with a view to protecting the valley of the Mississippi from overflow, improving navigation, and giving correct reports for the ben-

1600	1600	1700

AND I OUGHT TO BE WITH YOU IN THE MIDDLE OF THE NIGHT

eft of river men and planters. They were ordered by joint resolution of Congress approved February 21, 1871 (section 5252, Revised Statutes), viz:

SEC. 5252. The Secretary of War is hereby authorized and directed to have water gauges established and daily observations made of the rise and fall of the Lower Mississippi River and its chief tributaries at or in vicinity of St. Louis, Cairo, Memphis, Helena, Napoleon, Providence, Vicksburg, Red River Landing, Baton Rouge, and Carrollton, on the Mississippi between the mouth of the Missouri and the Gulf of Mexico; and at or in the vicinity of Fort Leavenworth, on the Missouri; Rock Island, on the Upper Mississippi; Louisville, on the Ohio; Florence, on the Tennessee; Jacksonport on the White River; Little Rock, on the Arkansas; and Alexandria on the Red River; and at such other places as the Secretary of War may deem advisable. The expenditure for the same shall be made from the appropriation for the improvement of rivers and harbors, but the annual cost of the observations shall not exceed the sum of \$5,000.

The above gauges were established the latter part of 1871, except Carrollton, established in January, 1872. A gauge was placed at mouth of White River instead of Napoleon, which was fast caving into the river. A gauge was established at Natchez, Miss., and an additional one at Louisville, Ky., one being needed at the head and one at the foot of the falls. Observations were commenced at each station as soon as the gauges were established, and with a few exceptions have been continued regularly since.

A gauge was established at Nashville, Tenn., on the Cumberland River, in August, 1873, and in 1890 four new gauges were established, viz: On Red River at Shreveport, La., February 20; Garland, Ark., February 21; Fulton, Ark., February 22; and on Mississippi River at Donaldsonville, La., June 9.

The gauge at Rock Island, Ill., was discontinued April 30, 1879, because observations so far upstream were not needed, and the old gauge at Fort Leavenworth, Kans., was abandoned November 30, 1886, but readings have been continued by the Missouri River Commission.

In 1881 bulletins were erected at the stations on the Mississippi for the purpose of giving passing steamboats the stage of water at each reading, and showing whether the river was rising, stationary, or falling. In 1890 these were replaced by larger bulletins (sheet-iron plates, 48 by 40 inches by one-sixteenth inch; white figures on black ground), more than twice the size of the old ones, and large enough to be read with the naked eye at a distance of half a mile. A photograph showing the new bulletin at Baton Rouge, La., which is a fair specimen, is sent herewith.* The old bulletins were repaired and used in extending this service upon the tributaries.

Since February 1, 1887, the gauges have been read and bulletins changed at 8 a. m. and 4 p. m. daily, to secure greater uniformity and accuracy; formerly they were read at 8 a. m. only.

The engineer gauges are used by the Signal Service at St. Louis, Mo., Cairo, Ill., Memphis, Tenn., Helena, Ark., Vicksburg, Miss., Nashville, Tenn., Alexandria, La., Shreveport, La., and Fulton, Ark.

During the fiscal year ending June 30, 1891, observations were continued at the twenty-two gauges. The readings are received at this office weekly, reviewed, consolidated, and sent to the secretary of the Mississippi River Commission. The readings have been published by the Commission to the end of the calendar year 1890.

Records of the daily readings were furnished the president of the Mississippi River Commission; copy of the Florence record was fur-

* Not printed.

nished the engineer in charge of Tennessee River; copy of the Carrollton record was sent the assistant engineer at South Pass of the Mississippi River, and copies of the records at various stations below Memphis were furnished district officers and levee commissioners during the flood this spring.

The following gauges were inspected by Assistant Engineer John Ewens, viz:

July.—(21st) Natchez, Miss.; (24th) Red River Landing, La., gauge rebuilt from 12 to 42.5 foot mark; (26th) Baton Rouge, La., gauge rebuilt from 3 to 25.5 foot mark; (27th) Donaldsonville, La.; (29th) Carrollton, La., gauge rebuilt from -2 to 17 foot mark, and position of bulletin changed on account of caving bank.

August.—(7th) Vicksburg, Miss., gauge rebuilt from 0 to 52.5 foot mark, and two additional bench-marks established; (15th) Lake Providence, La., gauge rebuilt from 0 to 44 foot mark, bulletin repainted, and new bench-mark established; (16th) mouth of White River, Ark., gauge rebuilt from 3 to 50.5 foot mark, and permanent stone bench-mark established; (18th) Memphis, Tenn., gauge rebuilt from -0.3 to 38.3 foot mark, bulletin repainted, and bench-marks tested; (22d) Helena, Ark., gauge repainted, and bulletin reset and repainted; (24th) Little Rock, Ark., bench-marks tested and level connections made with other gauges, and bench-marks of Arkansas River and Coast Survey.

September.—(1st) Garland, Ark., gauge rebuilt from 0 to 31-foot mark; (3d) Fulton, Ark., gauge rebuilt from 0 to 35.4-foot mark and zero lowered 3 feet, as old gauge was known to be too high, Signal Service gauge tested, high-water mark of 1890 leveled to and found to be 43.743 feet above zero of new gauge, and two additional bench-marks established; (5th) Shreveport, La.; (7th) Alexandria, La., gauge rebuilt from 15 to 26 foot mark and high-water section braced; (8th) Baton Rouge, La., gauge rebuilt entire from 0 to 38 foot mark; (10th) Donaldsonville, La., gauge reset, having been disturbed by steamer jamming piling to which it was attached; (11th) Carrollton, La.; (15th) Red River Landing, La., two new sections put in reading from 5 to 12 and 17 to 23.5 feet, and all sections braced; (18th) Natchez, Miss., gauge rebuilt from 6 to 20 foot mark.

November.—(5th) Vicksburg, Miss., bulletin repaired, reset, and painted; (18th) Shreveport, La.

June.—(9th) Shreveport, La.; (12th) Alexandria, La.; (21st) Red River Landing, La., gauge rebuilt from 19 to 36 foot mark; (23d) Natchez, Miss.; (25th) Vicksburg, Miss., gauge rebuilt from 14.5 to 30.4 foot mark.

The resolution of February 21, 1871, intended to provide an annual appropriation of \$5,000, but as it directed that the expenditure be made from the appropriation for rivers and harbors, and as that has been a biennial appropriation since 1882, it became evident that new legislation would be required or the work would have to be discontinued. In 1878 observations were stopped for want of funds, but many observers continued the readings without compensation. In 1884 a deficiency appropriation was made for their continuance. In 1886 the Mississippi River Commission paid the observers and repaired the gauges on the Mississippi to prevent observations being stopped, and in 1887-88 the funds ran out and the records were kept up voluntarily by the observers.

The value of the records requires that they shall be accurate and continuous, and to provide for this and to enlarge and perfect the system

the river and harbor act of August 11, 1888, made a permanent appropriation, as follows:

SEC. 6. That for the purpose of securing the uninterrupted gauging of the waters of the Lower Mississippi River and its tributaries, as provided for in joint resolution of the 21st of February, 1871, upon the application of the Chief of Engineers, the Secretary of War is hereby authorized to draw his warrant or requisition from time to time upon the Secretary of the Treasury for such sums as may be necessary to do such work, not to exceed in the aggregate for each year the amount appropriated in this act for such purpose: *Provided, however,* That an itemized statement of such expenses shall accompany the annual report of the Chief of Engineers.

The item of appropriation referred to in the above section was as follows:

For gauging the waters of the Lower Mississippi River and its tributaries as provided in joint resolution of 21st of February, 1871, \$9,600: *Provided,* That \$3,600 of same is authorized to be expended in paying the expenses of gauging the said waters during the fiscal year ending June 30, 1888.

The same act, in the item "for continuing operations upon the reservoirs at the head waters of the Mississippi River," provided for an allotment from the permanent appropriation for gauges, as follows:

And the Secretary of War shall cause such gaugings to be made at or near St. Paul during the annual operations of said reservoirs as shall determine accurately the discharge at that point, the cost of same to be paid out of the annual appropriation for gauging the waters of the Mississippi River and its tributaries.

Toward the end of the third year's work under this act, it was held that the amount which the Secretary of War might draw for this purpose was limited to \$6,000 a year, and as \$900 had been allotted for the work at St. Paul, this left but \$5,100 for continuing the observations under an approved project requiring the expenditure of \$8,700.

To comply with the law forbidding acceptance of voluntary service, and at the same time to avoid breaking the continuity of the observations, authority was obtained for temporary transfer of gauges on tributary streams in this district to the appropriations for their improvement, and of most of those on Mississippi River and the tributaries beyond the limits of this district to other officers. This involved an expenditure of from \$30 to \$60 from several appropriations for the quarter ending June 30, a trifling sum as compared with the value of the records to the several streams themselves as well as to the service at large.

The joint resolution of February 21, 1871, authorized the establishment and maintenance of gauges "at such other places as the Secretary of War may deem advisable," and it was under this provision that the number has been increased on Mississippi River and the service extended on the principal tributaries, and for which the appropriation of 1888 was increased and made permanent; both for the benefit of navigation and people living on the lowlands, and for preserving the continuity of the records.

It is recommended that the section relating to water gauges be fixed so as to prevent any doubt about the amount that may be drawn in each fiscal year.

As the value of the observations and the practical use of the bulletins become appreciated, requests are made by river men for new gauges or for bulletins at the important stations on the tributaries. Gauge stations have been established on tributary streams in connection with their improvement, some of which might be transferred to this service with great benefit to all concerned. A few stations on Red, Ouachita, and Yazoo rivers should be continued and bulletins erected on the large rivers outside the district, as Arkansas, Tennessee, and Cumberland rivers. Stations on bayous Bartholomew and Boeuf, Tensas River, and

Bayou Maçon would be valuable to the people living in the district subject to overflow to give warnings of approaching floods and to inform river men of the amount of water on the shoals, thus enabling them to know when to make trips, how far they could go, and what depth to load.

To give the greatest value to the records the zeros of the gauges should be connected with the Cairo datum, the common reference plane of the Engineer Department and the Mississippi River Commission, and through that to mean Gulf level. Many of them have been fixed, but some of those on the distant streams remain to be connected. Fortunately the lines of precision of the Coast Survey, Commission, and the Engineer Department Survey of Red River are so extensive that but few lines of levels are needed. Red River will have a continuous line from Fulton to Mississippi River by next year. Arkansas River is paralleled from the Mississippi to Little Rock by the Coast Survey line, from which Upper Ouachita, Bayou Bartholomew, St. Francis, and White rivers can be reached. Middle Ouachita is crossed by the precise line from Vicksburg to Shreveport, and Lower Ouachita and Black rivers and the mouths of Tensas and Bayou Boeuf are within easy reach of the Coast Survey bench at Vidalia. The line to Shreveport crosses Tensas, Maçon, Boeuf, Ouachita, and the Dorchest. Yazoo River needs but one line from Greenville to the mouth of Tallahatchee River, 55 miles, to give the elevation of high and low water of early years and to recover the elevations of the Delta Survey of 1858 at Prentiss and Napoleon. The Coast Survey line up the Mobile and Ohio Railroad will serve as a base for the gauges on Tennessee River, while those on Ohio River can be reached from the transcontinental line. This work should be done gradually so as not to involve a large expenditure in any one year, or the necessity of organizing a special party. The most economical method would be to extend the work of the gauge inspector and run the shorter lines of level from time to time when he should be convenient to the stations to be connected.

The search for the benches of the Delta survey has been continued and the level note books of 1851 and 1858 reviewed. It was intended to visit all of the old stations in May and June and verify the record, but the lack of funds prevented. It is hoped by another year that the subject will be exhausted. The following stations are believed to have been found beyond all doubt: Cairo, Memphis, Vicksburg, and Baton Rouge; while Natchez and Carrollton are in dispute and can be determined only by getting the elevation of known points to which they are connected by levels on certain section lines. Helena, Napoleon, Prentiss, Lake Providence, and Red River Landing may be restored by comparing elevations of high-water marks, found in a similar way, with plotting of the high-water lines drawn between known stations of the survey. The gauges at Little Rock and Natchez need investigating, as recent examinations of the records indicate errors in placing the zeros in reestablishing the gauges at points other than those selected by Colonel Merrill. The zeros will not be changed, but a correction applied to the record if found necessary. The height of mean Gulf level above the Cairo datum is about 21 feet, but no agreement has yet been made between the Coast Survey and the Commission for a final value. By the former the height is 20.88 and by the latter 21.26, either of which is accurate enough for practical use.

The recommendation of former reports that the gauge service should be under one management is repeated in the interest of economy and good service. There are several gauges in each district on Mississippi

River between St. Louis and New Orleans, the reports of which are sent to the secretary of the Commission, but the records of all can not be equally valuable, since the gauges are not inspected regularly or uniformly. Rigid inspection is necessary to insure careful observations and to maintain the gauge zeros invariable, to insure a well ordered and efficient service, and this can be obtained in no other way without great cost.

Comparison of flood of 1891 with highest water previously recorded.

Gauge stations.	Elevation of gauge zero above Cairo datum plane.	Elevation of gauge zero above mean Gulf level at Biloxi, Miss. (preliminary). [*]	Highest water previously recorded.		Highest water during fiscal year ending June 30, 1891.		Relation to previous highest record (below).
			Year.	Gauge reading.	Date.	Gauge reading.	
	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>	<i>Feet.</i>
St. Louis, Mo.	400.23	378.97	1844	41.39	Apr. 25	23.61	17.78
Cairo, Ill.	290.84	269.58	1883	52.17	Mar. 4-6	46.20	5.97
Memphis, Tenn.	203.97	182.71	1890	35.60	Mar. 10	34.90	.70
Helena, Ark.	161.98	140.72	1886	48.10	Mar. 27-28	44.70	3.40
Mouth White River, Ark.	128.73	107.47	1890	50.40	Apr. 5	47.72	2.68
Lake Providence, La.	89.62	68.36	1890	41.05	Apr. 1-4	41.00	.05
Vicksburg, Miss.	66.04	44.78	1862	51.10	Apr. 2-4	48.10	3.00
Natchez, Miss.	36.89	15.63	1862	50.30	Apr. 11-12	46.50	3.80
Red River Landing, La.	23.85	2.59	1890	43.77	{ Apr. 26 } to May 4	45.48	3.29
Baton Rouge, La.	20.06	— 1.20	1890	36.58	May 3 and 5	35.55	1.03
Donaldsonville, La.	†19.71	— †1.55	1884	29.45	Mar. 18	27.90	1.55
Carrollton, La.	20.91	— 0.35	1890	16.13	Mar. 16	16.00	.13
Louisville, Ky. (upper)	†419.78	†398.50	1884	46.60	Feb. 27	32.40	14.20
Louisville, Ky. (lower)	†392.85	†371.59	1884	72.00	Feb. 26, 27	58.00	14.00
Florence, Ala.			1867	31.08	Mar. 15	22.20	8.88
Nashville, Tenn.			1882	55.10	Mar. 14	49.30	5.80
Jacksonport, Ark.			1890	33.35	Apr. 26	23.75	9.60
Little Rock, Ark.	†241.55	†220.29	1857	31.00	Apr. 24	22.70	8.30
Alexandria, La.	64.46	43.20	1890	36.85	Feb. 16, 17	29.95	6.90
Shreveport, La.	161.27	140.01	1890	34.70	Feb. 12, 13	25.20	9.50
Garland, Ark.	223.44	202.18	1885	28.34	Apr. 28	27.64	.70
Fulton, Ark.	244.78	223.52	1876	35.75	Apr. 27, 28	30.30	5.45

^{*} Mississippi River Commission preliminary value; 21.26 feet above the Cairo datum plane.

† Preliminary value.

To provide for the judicious extension of the service, maintenance of gauges, and gradual level connections, the following estimates are submitted for the fiscal year 1893, and recommended to be substituted for the amount appropriated by the act of August 11, 1888:

Wages of observers	\$5,000
Repairs of gauges and bulletins	800
Pay of inspector, wages of extra help at stations, and traveling expenses...	2,700
Permanent monuments	300
Level connections	2,000
Record books, blanks, stationery, telegrams, etc.	200
Office expenses	500
Mileage and transportation	500
Total	12,000

ITEMIZED STATEMENT OF EXPENDITURES DURING THE FISCAL YEAR ENDING JUNE 30, 1891, SUBMITTED IN COMPLIANCE WITH REQUIREMENTS OF SECTION 6 OF THE RIVER AND HARBOR ACT OF 1888.

Observations:

Pay of 20 permanent gauge-keepers from July 1, 1890, to March 31, 1891, inclusive	\$2,610.00
Pay of 1 permanent gauge-keeper at St. Louis, from August 7, 1890, to March 31, 1891, inclusive	117.00
	\$2,727.00

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Inspection and repairs:

Pay of assistant engineer 8 $\frac{1}{2}$ months, at \$150	\$1,225.00
Traveling expenses of assistant engineer while inspecting gauges	196.30
Pay of persons hired to assist gauge inspector, and to repair and paint gauges, erect bulletins, etc	176.05
Repair of level rod	1.00
Material for repairs of gauges	19.60
Transportation of material	10.50
Mileage of officer in charge	41.00
Photograph camera	54.25
	<hr/>
	\$1,723.70

Office expenses and contingencies:

Office pay rolls	450.00
Stationery	28.25
Transportation of note books and maps of Delta survey from Engineer Department	5.40
	<hr/>
	483.65

Total amount expended during year..... 4,934.35

- Seventeen permanent gauge-keepers were paid for the last quarter of the fiscal year 1891 from appropriations for other works, as stated in body of this report, as the reduced amount allowed under the new construction of the act of August 11, 1888, was not sufficient to pay them.

The outstanding liabilities July 1, 1891, were as follows:

Telegrams during fiscal year 1890	\$5.19
Telegrams during fiscal year 1891 .....	.68
Pay of deceased gauge-keeper at St. Louis, Mo.	11.00
Pay of 4 permanent gauge-keepers from April 1, 1891, to June 30, 1891, inclusive	195.00
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Total amount outstanding..... 211.87

Money statement.

July 1, 1890, amount available (provided by act of August 11, 1888)	\$9,600.00
Amount allotted for gaugings at St. Paul	900.00
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Amount authorized to be expended for gauges in this district by project approved August 19, 1890	8,700.00
Amount of outstanding liabilities of fiscal year 1890	5.19
	<hr/>

July 1, 1890, total amount available	8,705.19
June 30, 1891, amount expended during fiscal year	\$4,934.35
Amount withheld at Treasury United States	3,523.53
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	8,457.88

July 1, 1891, balance unexpended	247.31
July 1, 1891, outstanding liabilities	211.87
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July 1, 1891, balance	35.44
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{ Amount that can be expended profitably in fiscal year ending June 30, 1893	12,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

V 19.

SURVEY OF CYPRESS BAYOU AND THE LAKES BETWEEN JEFFERSON, TEXAS, AND SHREVEPORT, LOUISIANA, TO ASCERTAIN IF NAVIGATION CAN BE MATERIALLY AND PERMANENTLY IMPROVED BY THE CONSTRUCTION OF LOCKS AND DAMS, AND THE PROBABLE COST THEREOF.

This survey was ordered by the following item of the river and harbor act of September 19, 1890:

The Secretary of War is hereby directed to cause a survey to be made of Cypress Bayou and the lakes between Jefferson, Tex., and Shreveport, La., in order to ascertain if the navigation of the said bayou and lakes can be materially and permanently improved by the construction of such dams, and locks and dams, as may be necessary, and if found practicable the probable cost thereof, and for this purpose \$10,000, or so much thereof as may be necessary, is hereby appropriated.

PROGRESS REPORT.

The late date on which the appropriation became available made it necessary to postpone this survey until late in the year. In accordance with the approved project required by law the survey party was organized under Assistant Engineer H. M. Marshall, at Vicksburg, and began operations on the survey of the mouth and part of Yazoo River, and continued on that work until driven out by high water December 6, 1890. The party was transferred immediately to Shreveport, and, the quarter-boats having been repaired and fitted out in advance, began work on the survey of Twelve-Mile Bayou and the lakes, December 8. Progress was greatly impeded throughout January by high water through the outlets from Upper Red River, which submerged the low banks of the lakes and bayous. By April the water had fallen sufficiently to resume the survey, and the field work was completed by the middle of the month.

The triangulation covers the entire basin and connects with the system of the Red River Survey, and the precise levels were carried to the limit of the high lands, and thence connected by ordinary spirit levels with the line to Jefferson, the country being too difficult for the former. The notes of triangulation and levels have been computed and tabulated, and the topography and hydrography is ready for plotting.

It was found necessary as the survey developed to join on with the Upper Red River survey to find the outlets through which the water supply came to the lakes, and which will gradually be cut off by the west bank line of levees.

As the estimate called for \$12,000, if the work should be found necessary, it is to be regretted that the full amount of the estimate was not granted. Before any intelligent opinion can be formed of the advisability, durability, and cost of locks and dams, or of any other reasonable plan for giving navigation to Jefferson when boats can reach Shreveport, it will be necessary to make borings along the trial lines to determine both the character and depth of the material to be moved, and of the foundations for construction. Borings were included in the approved project for the survey, but the high stage of water that prevailed during most of the time the party was in the field would not have permitted them to be made, even had there been funds for the purpose. The work will have to be done at low water and by skilled workmen, in order to get the information before flood. An appropriation of \$2,000 is recommended for this purpose.

The maps are now being laid out from the field sheets, and it is

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hoped that they will be finished in time to prepare a special report, and submit all to the Department before Congress meets.

Money statement.

Amount appropriated by act approved September 19, 1890.....	\$10,000.00
June 30, 1891, amount expended during fiscal year.....	9,897.99
July 1, 1891, balance unexpended	102.01
July 1, 1891, outstanding liabilities	3.84
July 1, 1891, balance available.....	98.17
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{ Amount (estimated) required for completion of existing project.....	2,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	2,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

V 20.

PRELIMINARY EXAMINATION OF CANE RIVER, LOUISIANA, WITH A VIEW TO ITS IMPROVEMENT BY LOCKS AND DAMS FOR THE PURPOSE OF GIVING PERMANENT NAVIGATION THE YEAR ROUND.

[Printed in House Ex. Doc. No. 184, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS, UNITED STATES ARMY, *Washington, D. C., January 15, 1891.*

SIR: I have the honor to submit the accompanying copy of report, dated January 7, 1891, by Capt. J. H. Willard, Corps of Engineers, giving results of preliminary examination of "Cane River, Louisiana, with a view of improving the same by locks and dams for the purpose of giving permanent navigation the year round," made in compliance with provisions of the river and harbor act of September 19, 1890.

It is the opinion of Captain Willard and of the Division Engineer, Col. C. B. Comstock, that Cane River is not worthy of improvement, and I concur in the views of these officers.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF CAPTAIN J. H. WILLARD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE, *Vicksburg, Miss., January 7, 1891.*

GENERAL: I have the honor to submit the following report upon the preliminary examination of "Cane River, Louisiana, with a view to improving the same by locks and dams for the purpose of giving permanent navigation the year round," required by sections 17 and 18 of the act of Congress approved September 19, 1890, assigned to me by your letter of September 20, 1890.

Cane River is one of the abandoned channels of Red River, left out on the westward by cut-offs about 1825 and 1849. It is about 75 miles long from Red River near Grand Ecore to Red River near Colfax, made up of pools, bayous, and swamps, and interrupted by deposits considerably higher than the average stage of the main river. The bars have risen above the low-water line of Red River to such a height that Cane River can not be entered from above except at flood stages, and navigation is not open at the mouth to boats drawing over 4 feet until Red River has risen to a stage above 20 feet on the gauge at Alexandria, 34 miles below, the nearest point of reference. This gauge was established December 26, 1871, and observations have been taken continuously since that date. The zero was set at the low water of that year, the lowest then ascertained, but the river has fallen below that point almost every year to the present time, reaching minus 3.7 feet on the gauge in 1881.

I made the following table from the original records of the Alexandria gauge to show the behavior of Red River at that point, and to give all the information needed for the present discussion of any plan for improving Cane River.

Gauge on Red River at Alexandria, La.

Year.	No. days above 20 feet.	High-water months.	No. days at or below zero.	Low-water months.	Highest gauge.	Lowest gauge.	Remarks.
1872	66	Apr., May, June	82	Sept., Oct., Nov., Dec.	+33.30', Apr. 20	-2.60', Dec. 7-12	= Low water, 1871.
1873	40	June, July	81	Sept., Oct., Nov., Dec.	+30.30', June 19, 20	-0.00', Sept. 24	
1874	107	Mar., Apr., May, June	69	Aug., Sept., Oct., Nov., Dec.	+34.00', May 8-10	-2.00', Sept. 26-28	
1875	31	Apr., May	59	July, Aug., Oct., Nov., Dec.	+32.90', May 27	-2.20', Nov. 22, 23	
1876	123	Feb., Mar., Apr., May	92	Sept., Oct., Nov., Dec.	+32.90', Apr. 17	-1.90', Nov. 16-24	Lowest recorded.
1877	39	Apr., May, Dec.	88	Jan., Aug., Sept., Oct.	+25.45', May 18, 19	-2.60', Oct. 14, 15	
1878	109	Jan., Feb., Mar.	66	Oct., Nov., Dec.	+27.30', May 14	-2.60', Nov. 1-5	
1879	0	May	172	July, Aug., Sept., Oct., Nov., Dec.	+19.20', May 26	-3.10', Nov. 27-30	
1880	17	Apr., May	34	Jan., Oct., Nov.	+21.80', Apr. 11-13	-1.60', Oct. 29	Lowest recorded.
1881	52	Feb., Mar., Apr., May	91	July, Aug., Sept., Oct.	+27.85', Mar. 17-19	-3.70', Sept. 8	
1882	121	Jan., Feb., Mar., Apr., May, June, Dec.	0	Sept., Oct.	+34.85', Mar. 27	+1.25', Oct. 19, 21, 22	
1883	78	Feb., Mar., Apr., May	51	Aug., Sept., Oct., Nov.	+25.45', Mar. 30, 31	-2.30', Oct. 19, 21, 22	
1884	116	Feb., Mar., Apr., May, June	102	Aug., Sept., Oct., Nov., Dec.	+35.25', May 1, 5	-1.90', Nov. 3-5	June 14-16, 1886, 44 hours rain. River rose from 3.8' to 28.75'. June 16, 5 p.m. Local storms.
1885	105	Jan., Feb., Mar., Apr., May, June	75	Aug., Sept., Oct., Nov., Dec.	+34.30', Jan. 25	-2.05', Oct. 24	
1886	0	Mar.	88	July, Aug., Sept., Oct., Nov., Dec.	+17.70', Mar. 7	-2.20', Sept. 11-13	
1887	0	do.	105	Jan., Feb., Aug., Sept., Oct., Nov., Dec.	+14.92', Mar. 24	-3.00', Sept. 14-16	
1888	59	Mar., Apr., May, June	50	Jan., Feb., Dec.	+19.25', Dec. 28, 29	-2.20', Nov. 7	Highest recorded.
1889	55	Jan., Feb., Mar.	60	Aug., Sept., Oct., Nov., Dec.	+29.60', Mar. 27, 28	-2.20', Nov. 14	
1890	104	Mar., Apr., May, June	11	Aug., Sept., Oct., Nov.	+31.50', Feb. 13	+0.25', Sept. 21, 26	
Average for 10 years.	64	Mar., Apr., May	66	July, Aug.	+36.85', May 19	-0.10', Aug. 21, 26	
				Aug., Sept., Oct., Nov., Dec.	+28.50'	-1.82'	

Zero of gauge = 64.46 feet above Cairo datum plane = 43.20 feet Mississippi River Commission provisional mean Gulf level at Biloxi, Miss.

Maximum rise and fall = 40.55 feet.

Mean rise and fall = 30.32 feet.

At an high-water month, April.

Mean low-water month, October.

A abnormal rise of June, 1886, omitted from highest gauge readings.

(See remarks.)

From the 19 years' observations it will be seen that without any work of improvement Cane River is navigable for boats drawing 4 feet, entering below, for about 2 months in the year, usually between March and May; that it is not navigable for such boats, probably for none, for about 5 months, usually between August and December; and that during the remaining 5 months navigation is not to be counted upon.

Boats may navigate Cane River during the high-water months with sufficient regularity to acquire the name of a "line," but if they enter the river at other periods it is simply as a venture for one or two trips when the river is unusually high for the season of the year. Now, to make steamboating in Cane River profitable, it should be navigable during the cotton-shipping time, say October to March, but that is usually the low-water season in Red River, and when the river falls much below the zero of the Alexandria gauge navigation is suspended either at the mouth of Red River or at the falls of Alexandria, so that if Cane River were improved by locks and dams navigation would be limited to the canalized portion for a certain time during low and medium stages, and only available for general purposes when Red River should be high enough for loaded boats to navigate Red River between Colfax and the Mississippi.

Cane River was examined by Major Miller in 1882, who reported that the stream was not worthy of improvement nor the work a public necessity. The subreport, however, contained an estimate of \$7,665 for removing logs, snags, leaning trees, etc., upon which probably was based the appropriation of \$2,500 in the act approved July 5, 1884. (Report Chief of Engineers, 1884, page 1366.)

No further estimate having been made, Cane River was dropped from the list of navigable streams in this district after finishing the work contemplated in the expenditure of the amount allotted.

In preparing my report of February 21, 1890, upon a bill for a bridge to be built across Cane River at Natchitoches (act approved April 22, 1890), I tried to get information about the commerce of this stream, but with indifferent success. I was informed that the "Old River" had filled up so much that ordinarily it was not navigable for more than two months in the year, and that as the filling up was still going on the navigation became more and more doubtful year by year.

The estimated crop of the valley last year was 7,500 bales of cotton and 75,000 sacks of seed, or about one-third the estimate in the report of 1884, and in consequence of the uncertain navigation the greater part was hauled to the main river or to the Texas and Pacific Railway. If the water should be high at the cotton-shipping season it was expected that about five trips would be made by a boat of about 300 tons. The president of the parish police jury stated that no objection would be made by them to any bridge that might be built across Cane River, and considered the navigation of that stream as valueless to the people because of its uncertainty. Two boats made the trip last winter, but no report of the business could be obtained, and none could be procured of the business done during the year 1890.

Assistant Engineer Marshall connected the line of levels on Red River with points at the head and foot of Cane River in October and November, 1890, and made a report, which is given below.

This river, so called, is an old-time bed of Red River lying wholly within the parish of Natchitoches and was abandoned when the Rigolet du Bon Dieu became the main channel. I was not able to ascertain accurately the character or time of this change, which occurred about 1825.

Red River seems to have made a cut-off, via a bayou, from the hills at Grand Ecore, on the western side of the valley, into Saline River, where it skirted the hills on the eastern side at the present town of St. Maurice. Thence, following the bed of the

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Saline to its mouth, Red River returned to itself where now stands the town of Olafax. Cane River proper was at one time a short branch of Red River from the town of Natchitoches to Twenty-four Mile Ferry, and became the main channel when Red River abandoned what is now termed Old River. It is thus seen that Red River has from time to time changed its course, seemingly for no other reason than to shorten its route. The name Cane River is now applied to all the old bed from Natchitoches up to Red River, and from Twenty-four Mile Ferry down to Red River, as well as to the intermediate portion, extending in all a distance of about 128 kilometres.

When Louisiana was settled the land along this river was early sought out and brought under cultivation, and now constitutes the finest farms in the State. Cultivation is confined almost exclusively to cotton, which yields here most abundantly in quantity and excellent quality. There are no statistics kept of the commerce. A steamboat capable of carrying 1,800 bales of cotton made ten trips up the river last season. The town of Natchitoches, on the right bank, about 8 kilometres below the head of the river, has about 3,000 inhabitants. The Texas and Pacific Railway runs nearly parallel with, and from 2 to 10 kilometres from Cane River, from Natchitoches, where it leaves the river, down to the mouth.

Canalization is the only possible mode of improvement, because of the lack of water for any other method. There is a clean, clear bed, about 12 metres deep and 145 metres wide, high and dry above low water, save for the small stream supplied by the drainage area of 1,500 square kilometres. The annual rainfall is about 1.52 metres, or 2,280,000,000 cubic metres from the whole area, and the discharge at the mouth of Cane River was 1,000,000 cubic metres per day, with Red River 3 metres above extreme low water. The fall through Cane River is 4.7 metres at high water and 9.3 metres at low water from Natchitoches to the mouth. To the low-water fall must be added sufficient height to obtain reservoir capacity to supply water for lockage and leakage and to afford draft for boats, which would make the total lift about 14 or 15 metres. This being divided into 3 lifts of 5 metres each gives a reservoir capacity 271,000,000 cubic metres. With locks 20 metres wide and 60 metres long, each locking would require but 6,000 cubic metres. The discharge of Red River at extreme low water is probably about 6,000,000 cubic metres per day, and half of the above estimated capacity of Cane River would be sufficient to double the discharge of Red River at extreme low water for a period of 30 days. This canal could therefore be made incidentally of great advantage to Red River. The locks would cost about \$75,000 each, or \$225,000 for the whole work, but no reliable estimates could be made except after a survey of the site of the locks. It is known that rock foundation can be obtained at not a great depth, which would insure the feasibility of locking.

The following table shows relative elevations in metres above Cairo datum as determined by lines of levels at the head of the river, across to Natchitoches, and at the mouth, while the accompanying tracing* shows the geographical position.

Place.	High water, 1890.	Low water.	Top of bank.	Bottom of river.	
Head		30.0	36.0	30.0	} Cairo datum, 21.26 feet below Mississippi River Commission provisional mean Gulf level.
Natchitoches	39.5	30.8	42.0	30.6	
Mouth	34.8	21.5	35.0	21.2	

To sum up the results of the examination:

1. Cane River can be converted into a canal at a cost of about \$2,000 per kilometer.
2. The canal would be of great advantage to Red River at low-water season.
3. The prospective commerce on the canal is indefinite, but probably not considerable.
4. A survey would be necessary to determine location and cost of locks accurately.

Converting elevations from meters to feet, and using zero of Alexandria gauge for datum, the table with certain additions will show the depths and heights between the head of Cane River and Alexandria..

Place.	High water, 1890.	Low water.	Depth.	Height of banks.
Head of Cane River.....		33.97	0.0	53.65
Natchitoches	65.13	36.59	0.7	73.34
Mouth of Cane River	49.71	6.08	1.0	50.37
Upper Falls		1.48	8.0	35.00
Lower Falls		0.67	5.6	34.00
Alexandria gauge.....	36.85	0.00	8.0	34.20

* Not reprinted.

The following table gives the depths of the channel through the falls above Alexandria, corresponding to average and extreme low water on the gauge:

	Average low water, 19 years.	Extreme low water, September, 1881.
Alexandria gauge.....	-1.8	-8.7
Depth on Lower Falls.....	+3.9	+2.0
Depth on Upper Falls.....	+6.3	+4.4

The tables show that with a slope of less than five-tenths foot the river would have to be at least 20 feet on the Alexandria gauge to enable boats to enter the mouth of Cane River on 4 feet draft, thus agreeing with former reports and with the statement of pilots engaged in the Red River trade. They also show that Red River would have to be improved by locks and dams at and above Alexandria to give "permanent navigation the year round" of at least 6 feet, without which the desired improvement of Cane River could not be used at midsummer low stages of Red River except for local business, as already stated.

Major Howell submitted projects in 1874 for locks and dams, and a canal at the falls of Alexandria to cost from \$80,000 to \$100,000, but the work was only intended to relieve navigation over the falls. No action was taken upon the plan, and as a survey is now in progress to furnish a basis for a permanent improvement of Red River, it is not probable that anything will be done until a new plan has been submitted (Report Chief of Engineers, 1875, page 904). I do not think it necessary, therefore, to review Assistant Engineer Marshall's approximate estimate of \$225,000 for three locks, except to say that unless the sites should happen to fall where the firmest foundations could be had, it is my opinion that a lift of 15 feet would be too great, and that four or probably five locks and dams would be required. This would increase the cost of the improvement very materially.

The estimate, however, is much too small, for, as the river rises and falls nearly 40 feet, the locks would have to be of the most substantial type of masonry, as they would be submerged during floods, and the dams would have to be provided with navigable passes, to be used as soon as the water would reach a stage that would prevent maneuvering the gates.

No estimate can be made of the probable cost of such an improvement without an exhaustive survey to determine the number and positions of the dams, the character of the foundations, and the amount of revetment and levee work that might be needed; and this would be an expensive undertaking.

By using the survey of Red River from Grand Ecore to Alexandria on the one hand, and the levels of the Texas and Pacific Railway on the other, it may be done for \$12,000, provided there should be no serious interruptions on account of high water or sickness. I do not recommend the survey, however, because I do not consider Cane River worthy of improvement by locks and dams or by any other method, or the work a public necessity. On the contrary, following the principles that should govern in any plan for improving Red River, Cane River should be treated as an injurious outlet, and its upper end, which has been gradually filling up, should be permanently closed by a dam and levee

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to confine the flood waters to the main river. No further examination or survey is necessary.

Very respectfully, your obedient servant,

J. H. WILLARD,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, January 12, 1891.

Respectfully forwarded to the Chief of Engineers.

For the reasons stated, I concur in the opinion of the district officer that Cane River is not worthy of improvement by locks and dams, as suggested in the river and harbor act of September 19, 1890, section 17.

C. B. COMSTOCK,
*Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.*

V 21.

PRELIMINARY EXAMINATION OF BAYOU CASTOR, LOUISIANA.

[Printed in House Ex. Doc. No. 185, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 15, 1891.

SIR: I have the honor to submit the accompanying copy of report dated January 7, 1891, by Capt. Joseph H. Willard, Corps of Engineers, upon the preliminary examination of Bayou Castor, Louisiana, made in compliance with requirements of the river and harbor act approved September 19, 1890.

In view of the small commercial interests to be benefited Captain Willard is of the opinion that the locality is not worthy of improvement. This opinion is concurred in by the Division Engineer, Col. C. B. Comstock, Corps of Engineers, and by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF CAPTAIN J. H. WILLARD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., January 7, 1891.

GENERAL: I have the honor to submit the following report upon the preliminary examination of Bayou Castor, Louisiana, required by sections 17 and 18 of the act of Congress approved September 19, 1890, and assigned to me by your letter of September 20, 1890.

Bayou Castor, with its tributary creeks, drains a portion of the country south of the Vicksburg and Shreveport Railroad and west of the Ouachita River, flowing from 6 to 8 miles from the latter for a considerable distance above and below Columbia. Its general course is southerly to its junction with Dugdemona River, latitude $31^{\circ} 50'$, longitude $92^{\circ} 20'$, forming Little River, a stream that flows into what is called Catahoula Lake, which is drained into Red River and Ouachita, and sometimes filled by high water from the latter through another Little River at Trinity, where the "Four Rivers" meet. Catahoula Lake is dry in summer and grass grown. Bayou Castor is the same kind of stream as Dugdemona River, which was examined by me in 1887 and reported as not worthy of improvement. Assistant Davis reported Dugdemona River as only a tortuous creek, flowing through an uninhabited swamp about 2 miles wide, the surrounding country hilly, and the soil thin. (Report Chief of Engineers, 1887, page 1489).

Assistant Engineer R. S. Buck, jr., was dispatched from the Red River survey at Alexandria, La., October 16, 1890, and directed to make a personal examination of Bayou Castor, beginning at the mouth and ascending as high as practicable. The following is taken from his report:

We arrived at Alexandria October 16. There I left the *Florence* and, securing the services of a double team and driver, proceeded across country to the mouth of Bayou Castor, a distance of 42 miles. I arrived there on the morning of the 17th and went up the bayou about half a mile in order to sound and get current velocity in that vicinity.

After leaving the mouth I proceeded up the bayou as far as Castor Sulphur Springs, about 25 miles from the mouth. On account of the density of the swamps on both sides of the bayou and the numerous sloughs and tributary bayous it was impossible to follow the bayou closely after the road left it, either in a vehicle or on horseback, and it would have been useless work of many days to attempt it on foot. Further, the bayou at that stage was so blocked up with logs and snags that even if a skiff or dug-out had been procurable it would have been impossible to go up by that means.

However, I struck the bayou wherever it was practicable to do so, and saw enough of it and secured sufficient information from the natives to ascertain the value of the stream and the advisability of attempting improvement.

Bayou Castor in conjunction with Dugdemona River forms Little River, and, at the stage at which it was examined, furnishes not more than one-tenth as much water to that river as the other tributary. This is not so much on account of difference in cross section as in current velocity. The current in Bayou Castor near its mouth is about one-third mile per hour, while that of Dugdemona River is not less than 2 miles per hour.

Bayou Castor is of very uniform cross section, with steep banks, and throughout its entire length is a succession of bends more or less sharp. There are no marked irregularities or bar formations. As high as Castor Sulphur Springs it runs through dense swamps and its banks are covered with underbrush and trees down to the water's edge. The channel is filled with snags, brush, cypress trees, and knees.

From parties well acquainted with the bayou I learned that the character of the stream, though greatly diminished in size, and the country through which it runs is much the same above Castor Sulphur Springs as below. From top to top of banks near the mouth the bayou is about 200 feet wide, and from water's edge to water's edge about 60 feet. In that vicinity soundings in the deepest part ranged from 3 to 5 feet. The water was 2 feet above lowest stage. There the banks are from 17 to 20 feet high and the water in time of flood reaches 8 or 10 feet over the banks. The range of fluctuation is, therefore, about 30 feet.

At the Pendarvis place, 10 miles above the mouth, the banks are about 25 feet high; from top to top of banks the bayou is 175 feet wide; from water's edge to water's edge 40 to 50 feet. Velocity of current in pools is about one-half mile per hour; on rapids about 2 miles per hour. Stage about 2 feet above extreme low water. Depth from 2 to 3 feet. The bayou breaks up into a succession of pools and rapids about 7 miles above the mouth.

At the Pendarvis place the back water reaches about 20 feet above low water, but freshet from above has reached as high as 40 feet above low water. This excessive flood height is doubtless due to great contraction of high-water section caused by the hills coming in to the bayou.

At Castor Sulphur Springs the bayou is 140 feet from top to top of banks and 45

feet from water's edge to water's edge. The banks are about 15 feet high and the water 5 feet deep when 5 feet above extreme low water, at which stage the bayou is almost dry.

Backwater has never reached a higher point than 3 miles below Castor Sulphur Springs; but freshet water reaches 30 feet above low water. No examination was made above Castor Sulphur Springs, as the impracticability of making any improvement below develops into impossibility above. As stated, the bayou runs through a dense swamp varying in width from one-quarter to 3 miles. In places the pine hills come up to the bayou bank.

Statistics as to the demands of commerce and the business done on this bayou are necessarily crude and uncertain. However, enough could be gathered for practical purposes, and I am liberal in allowances. From Castor Sulphur Springs to the mouth of the bayou there are four or five small plantations. The swamps bordering on the bayou are incapable of cultivation, the places being on the hills.

The highest point ever reached by a steamboat was 3 miles below Castor Sulphur Springs, or 22 miles above the mouth. The highest point reached by steamboat during past 23 years (according to E. H. Pendarvis) was 8 miles above the mouth. However, flat boats for carrying out staves have gone higher. The bayou is navigable during 4 or 5 months in the year. One or two boats go up the bayou in a season.

The amount of business done yearly is about as follows:

Pine logs rafted, 20,000, at about 60 cents per log	\$12, 000
Staves carried out, 10, 000, at about \$125 per 1,000	1, 250
Cotton and merchandise uncertain and inconsiderable, but about	2, 000

Total 15, 250

So the amount of business done on this bayou can not exceed by liberal estimate \$16,000.

From Castor Sulphur Springs to the mouth the Houston, Central Arkansas and Northern Railroad runs at a distance from the bayou in most places not exceeding 1 or 2 miles, and never exceeding 4 miles.

Except when high water is backed up from below no boat can get up the bayou. When the bayou is high from head water the fluctuation is too rapid and the current too strong to admit of navigation among the sharp bends, overhanging trees, and cross currents.

An estimate of the cost of clearing the channel of trees, cypress knees, and snags, and the banks of overhanging trees can be put at \$200 per mile, or for the 25 miles up to Castor Sulphur Springs, \$5,000. After this is done it is questionable if navigation would be more than slightly facilitated, because of sharp bends and swift currents. Cutting bends and thereby straightening the stream is altogether impracticable and no remedy for existing difficulties. In fact the character of the stream and the country through which it flows, in my opinion, renders any attempt at improvement inadvisable.

The railroad mentioned above now forms part of the Missouri Pacific system. It connects with the Iron Mountain and Southern Railway near Arkansas City, touches the Ouachita at Monroe, and crosses it near Columbia, La., and runs near and parallel to Bayou Castor, crossing Little River just below the junction of Bayou Castor and Dugdemona River upon a fixed bridge, approved as authorized by the act of Congress approved August 6, 1888. The road is now in operation southward as far as the crossing of the Ouachita, about 4 miles above Columbia, and will perhaps be completed during the year as far as Alexandria, on Red River.

The chief function of these streams is to drain the neighboring country, and the only business done on them is rafting timber and floating out staves on flatboats. Some years ago, it is said, a small steamboat ascended Dugdemona River nearly as high as Winnfield, but could not find a place to turn around and had to back down. The boat barely escaped loss, the upper works being carried away by overhanging timber during the trip down stream. Little River, from the junction of Dugdemona and Bayou Castor, was examined in 1887 and reported unworthy of improvement except for about 25 miles between Catahoula Lake and Ouachita River, at Trinity, La., for which an estimate of \$2,500 was made "to complete." The amount was appropriated and has been expended, and no further estimate has been made for the purpose.

The small amount of business of the country along Dugdemonia and Bayou Castor has been done by teaming to Ouachita River, or by flat-boat down through Little River. This will soon be absorbed by the new railroad, so that there should be no need of improving Bayou Castor, even if it were practicable.

Assistant Engineer Buck's estimate of \$200 the mile, or \$5,000 for the 25 miles from Castor Sulphur Springs to the mouth, is, in my opinion, much too low. The stream has never been worked and is obstructed by raft, stumps, and heavy timber and brush to the water's edge. It would cost not less than \$200 the mile to clean both banks, \$300 the mile, or more, to clear the channel, with an extra allowance for cutting the sharp points to enable boats to make the bends. The current being sluggish, the greater part of the timber removed would have to be hauled beyond overflow to prevent forming new obstructions before the work should be finished. Incidentally the work would benefit the neighboring country by improving the drainage and reclaiming lands now under water.

In view of the facts set forth, I do not think Bayou Castor, Louisiana, worthy of improvement or the work a public necessity. No further examinations or surveys are needed.

Very respectfully, your obedient servant,

J. H. WILLARD,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, January 12, 1891.

Respectfully forwarded to the Chief of Engineers.

For the reasons stated I concur in the opinion of the district officer, that Bayou Castor is not worthy of improvement by the United States.

C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.,
Division Engineer.

APPENDIX W.

IMPROVEMENT OF ARKANSAS RIVER, ARKANSAS, INDIAN TERRITORY, AND KANSAS, AND OF CERTAIN RIVERS IN ARKANSAS AND MISSOURI.

REPORT OF CAPTAIN H. S. TABER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|---|--|
| 1. Removing obstructions in Arkansas River, Arkansas, Indian Territory, and Kansas. | 6. Cache River, Arkansas. |
| 2. Arkansas River, Arkansas, Indian Territory, and Kansas. | 7. Little Red River, Arkansas. |
| 3. Fourche River, Arkansas. | 8. Black River, Arkansas and Missouri. |
| 4. Petit Jean River, Arkansas. | 9. Black River, Missouri. |
| 5. White River, Arkansas. | 10. St. Francis River, Arkansas. |
| | 11. St. Francis River, Missouri. |
| | 12. Little River, Missouri and Arkansas. |

EXAMINATION.

13. Current River, from Van Buren, Missouri, to its mouth.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., July 1, 1891.

GENERAL: I have the honor to transmit herewith the annual reports for the fiscal year ending June 30, 1891, upon the works under my charge.

I am, sir, very respectfully, your obedient servant,

H. S. TABER,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

W 1.

REMOVING OBSTRUCTIONS IN ARKANSAS RIVER, ARKANSAS, INDIAN TERRITORY, AND KANSAS.

As the first expenditure of money on this river was made as early as 1833, it is not an easy matter to determine what was the original condition of the navigable portion of this stream, but from the delta-like

character of its lower portion and the tendencies now manifest in its upper reaches, it may be inferred upon very substantial grounds that shifting sand bars, numerous drift piles, and dangerous snags characterized the obstacles to navigation in the lower reaches; and gravel and rock shoals, with a few snags and many overhanging trees, constituted those of the upper reaches. The records of this office indicate that, except at a few places, such as Pine Pluff, Ark., and Fort Smith, Ark., the general plan of improvement has consisted of snagging operations, which includes cutting overhanging trees, and in building wing dams to improve the shoals, the idea being to afford temporary relief to navigation until complete surveys should render it possible to project a plan for the radical and permanent improvement of the navigable portion of the entire river. For the exceptions noted attention is respectfully invited to reports upon these special cases. The appropriations have been made sometimes for the entire navigable reach and sometimes for certain sections. The grand total of all these appropriations up to June 30, 1891, amount to \$485,251.37. Of this there had been expended up to June 30, 1890, \$391,288.67, exclusive of certain sums aggregating over \$100,000 that were appropriated with the Mississippi and Missouri rivers, so as not readily to be determined. The most permanent result of all this expenditure consists in a series of maps made by S. T. Abert from a survey of the river from Fort Gibson, Ind. T., to Big Rock, Ark., 3 miles above Little Rock, Ark., in the year 1870, and also another series of maps from Wichita, Kans., to Fort Gibson, Ind. T., from a survey in 1884. From the nature of the case the balance of the work has been each year a repetition of that of preceding years. One iron-hulled snag boat and one light-draft wooden snag boat, with all the appliances necessary for snagging operations were the visible signs of the balance, while the gratitude of those interested in the navigation of the river for a navigation rendered yearly less and less dangerous by the operations of these two boats is the only evidence existing, and the only evidence to be expected, of work that must be done in a stream like this, until by some system of permanence, caving banks no longer exist and the annual quota of snags is no longer furnished. The most economical management of snag boats requires not less than \$35,000 annually to give absolutely indispensable aid to navigation, a navigation in which a vast amount of commerce is vitally interested.

During the fiscal year ending June 30, 1891, \$9,330.43 was expended in the care and running expenses of the United States snag boat *Wichita*. During most of that time the Arkansas River has been too high for effective snagging operations, yet during that time about 300 dangerous snags were removed, about 2,000 overhanging trees cut, and over 13,000 trees deadened. Pursuing the steady policy of operating the boat only at or near low water, the balance has been reserved for use during the next fiscal year. This will enable me for the first time to enter upon an effective and systematic removal of obstructions, but to do anything like thorough work the appropriation was much too small. There ought to be at least \$70,000 expended during the next fiscal year. From all present appearances the snag boat *C. B. Reese*, which has been offered for sale to the Mississippi River Commission and also to the Missouri River Commission, neither of which bodies wish to make the purchase, will make a good towboat for the work of improving Arkansas River, Arkansas, Indian Territory, and Kansas, and may be sold to that work for a sufficient sum of money to build an entirely new snag boat modeled after the *Wichita*.

The difficulty now contended with is that I have not sufficient plant to push snagging operations during the short period of extreme low water.

Efforts will be made to consummate this sale and build the new boat during the next fiscal year.

If on or about the opening of the fiscal year beginning July 1, 1892, the sum of \$70,000 could be in hand and an effective clearance of the Arkansas River could be secured, this would render it possible, with the advance in the permanent improvements, to maintain the channel free from snags by taking the two snag boats as towboats on the permanent improvements and using them for snagging operations such few times as might be necessary.

Further, the time has come in the progress of improvements on this river when it is my duty to recommend that, if possible, the money for snagging be appropriated under the same head as that for the permanent improvement of the river, as it will save in engineering and office expenses, as now two separate sets of papers have to be kept, whereas only one set of papers need be kept, and yet so much money might always be used for snagging purposes, the papers showing all the time exactly to what purpose moneys were applied. This would practically increase the plant available for both work and will be a matter of economy in many ways. The goal that has been so long sought in reference to the opening of the Arkansas River is rapidly being neared. It has taken persistent effort and strict adherence to a systematic plan in the face of much adverse criticism; but 3 years more of the same work will show that even with small appropriations, if there is an economical following of a carefully devised plan, a river very thickly populated with snags may be eventually opened.

COMMERCE.

As stated in this report this work was begun in 1833, and there are no records available in this office to show what commerce, if any, passed over this river. In 1852 a gentleman in Little Rock lost five out of six of the steamboats owned and run by him in one season, due to snags. Navigation must have been uncertain in 1833, and commerce light.

It is estimated that insurance and freight rates have been reduced one-third by the improvement already effected. As to effect upon rates of competing routes of transportation, there are many points where there is no competition. Where there are, cotton is carried at 25 to 50 cents per bale cheaper by water than by rail, and other merchandise accordingly. This must keep railroad rates down. As to prospective advantages to commerce, if completed, observation shows that whenever the snag boats, by thorough work, get the channel reasonably well cleared, the boats run night and day, eagerly taking advantage of the brief interval before appropriations fail and the annual crop of snags can not therefore be removed. As to benefits to community, if completed, nothing better can be furnished under this head than a letter from the Little Rock Board of Trade, of date as follows, viz:

LITTLE ROCK BOARD OF TRADE,
Little Rock, Ark., June 8, 1891.

DEAR SIR: Owing to considerable sickness during the month of May I was not able to give the attention to the collection of river statistics that I would have liked but I have made considerable effort to obtain the desired information and respectfully submit the following:

From the best information we can get the tonnage of freight carried has increased

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about 43 per cent. since our report of July 27, 1886, and the total tonnage in round numbers amounts to about 46,000 tons. This includes the freight carried by boats in and out of Little Rock, and not the entire river valley, the statistics for which we were not able to get. It is estimated that the river business would increase about 50 per cent. if the river was improved. The board certainly appreciates your efforts in behalf of our rivers, and sincerely trusts the necessary appropriations will be made by Congress to carry on this work, the importance of which can not be overestimated. Assuring you the board's hearty coöperation.

I remain yours, very truly,

E. S. GREENE, *Secretary.*

Capt. H. S. TABER,
U. S. Engineers.

To give the advantages to commerce if completed fully, would be to enter upon the commerce of a great State, and would require an amount of time for compilation and record that would be entirely out of the question. It is forecasting the future of the State's metropolis and railroad center. All that prevents two-thirds of the freight now sent and received at Little Rock from being handled by the river is the fact that there are months of great uncertainty, and the time lost by the boats exhausts the profits. The rapid increase in prosperity of this State during the 7 years spent at this office reminds me more of the frontier growth of the West than the growth of a State the age of this one. A just conception can only be formed by looking at some great fertile river valley in the Northern or Eastern States as they were years ago, and as they are now since settled up, with its river improved. What benefits have accrued to that community will surely accrue to this, with this addition, that the mineral resources of this valley are to be added. Its coal products alone and its wealth of timber will place it well to the fore. When the vast acreage of the Indian Territory is brought under cultivation its products must go this way. That well-known and exceedingly fertile State of Kansas will find Fort Smith and Little Rock its nearest water outlet eventually. It will be seen how difficult it is to handle this question briefly if it is borne in mind that with deep water to New Orleans from the Gulf, the Mississippi improved, and the Arkansas River navigable to Little Rock by boats drawing 5 feet of water, we have the conditions likely to exist when the improvement is completed. I have, therefore, only attempted to outline this matter, and trust that when this portion of the report is read a map of the territory covered may be had in mind, as this will probably be of itself the strongest proof that the benefits likely to accrue can but be too vast to be summarized in a report like this.

Money statement.

July 1, 1890, balance unexpended.....	\$1, 674. 89
Amount appropriated by act approved September 19, 1890.....	20, 000. 00
	<hr/>
	21, 674. 89
June 30, 1891, amount expended during fiscal year	9, 330. 43
	<hr/>
July 1, 1891, balance unexpended.....	12, 344. 46
July 1, 1891, outstanding liabilities.....	1, 227. 55
	<hr/>
July 1, 1891, balance available.....	11, 116. 91
	<hr/>
{ Amount (estimated) required for completion of existing project	35, 000. 00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	70, 000. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Expense account.

Pay rolls.....	\$6,936.28
Subsistence supplies.....	1,186.88
General supplies.....	727.89
Transportation.....	5.65
Traveling expenses.....	55.65
Fuel.....	342.35
Stationery.....	33.60
Rent.....	40.00
	<hr/>
	9,328.28
Reserved in United States Treasury for freight charges.....	2.17
	<hr/>
	9,330.43

W 2.

IMPROVEMENT OF ARKANSAS RIVER, ARKANSAS, INDIAN TERRITORY,
AND KANSAS.

Work during the past season has been carried on under three different acts of Congress.

By act approved August 5, 1886, \$75,000 was appropriated under this head, its distribution being indicated in the following words and figures:

Improving the Arkansas River, Arkansas: Continuing improvement, according to the plans and recommendations in Appendix V 13, Ex. Doc. No. 1, Forty-ninth Congress, of which there are to be expended \$8,000 at Pine Bluff; \$13,000 at Fort Smith, and \$10,000 at Dardanelle, or so much thereof under these sums respectively, as may be necessary at these points.

All of this money except a small sum out of the \$10,000 for Dardanelle having been expended prior to June 30, 1890, it is only necessary to summarize the project for Dardanelle, as follows: At Dardanelle the \$10,000 is to be expended in erecting a permeable dike above and opposite the town, in such a position as to remove the sand bar now in front of the wharves.

By act which became a law August 11, 1888, \$150,000 were appropriated under this head, its distribution being indicated in the following words and figures:

Improving Arkansas River, Arkansas: Continuing improvement \$150,000: *Provided*, That nothing herein contained shall authorize the Secretary of War to enter upon project of improvement of said river as set forth in the report of the Board of Engineers on improvement of Arkansas River from Wichita, Kans., to its mouth, dated New York City, March 16, 1888, and contained in House Ex. Doc. No. 234, Fiftieth Congress, first session.

Provided, That the Secretary of War shall expend the appropriation under this head with reference to the final improvement of this river as contemplated in the report of the Chief of Engineers for the year ending June 30, 1885, and as authorized in the act for the improvement of rivers and harbors, approved August 5, 1886, and in House Ex. Doc., No. 90, Forty-ninth Congress, first session, said methods to be applied as the Secretary of War may direct at such points between Wichita, Kans., and the navigable mouth of the Arkansas River at its junction with the Mississippi River, as he may deem for the best interests of commerce. And all moneys now to the credit of different sections of the Arkansas River, other than the appropriations for the operating of the snag boats, shall be available for use under this head; and in future the engineer in charge of this work and the Secretary of War shall make report upon the progress and needs of this work under this head instead of reporting upon disconnected projects as heretofore. Nothing herein contained shall be understood to prevent the Secretary of War from applying any part or all funds previously appropriated for use at Fort Smith, Dardanelle, in Pine Bluff Reach, or from expending not exceeding \$8,000 as a contingent fund for expenditure in Pine Bluff Reach.

By act approved September 19, 1890, \$180,000 were appropriated, its distribution being indicated as follows:

Improving Arkansas River, Arkansas, Indian Territory, and Kansas. Continuing improvement from Wichita, Kans., to its mouth, \$180,000.

The approved projects for the expenditure of this sum may be summarized as follows:

At Pine Bluff, the \$8,000 is to be used in extending and repairing the dikes, a portion of it to be held as a contingent, to watch the action of the river; the idea being to cause the river to become less and less dangerous to the town front. At Van Buren, the \$4,000 to be expended in erecting a permeable dike at a suitable point a little above the town and upon the opposite side of the river, to contract the channel and prevent it from leaving the city wharves. From Fort Gibson, Ind. T., to the mouth of the river, the balance to be expended in the erection of permeable dikes, and in one instance by rock excavation at the worst places, or the places at which serious interference with the largest amount of commerce occurs, so far as the amount of appropriation will permit, looking towards the permanent improvement of the river, to give a channel at least 6 feet deep and 200 feet wide from Little Rock to the mouth of the river, via White River Out-off, as provided under the act of August 5, 1886, and an all-year-round depth of water of at least 2 feet from Little Rock, Ark., to Fort Gibson, Ind. T.; under all acts the work to be carried on by hired labor and the purchase of material in open market, as this is believed to be most economical and advantageous to the Government. Before operations were begun at Dardanelle a bad bar had formed along the town front, cutting off all approach to either wharf at low water or at medium stage. At Pine Bluff, the condition before improvement may be found by referring to the report "Improving Arkansas River, Arkansas," "Pine Bluff," Annual Report Chief of Engineers, 1887, page 1515, and was of so grave a nature that re-enumeration here would occupy too much space. From Fort Gibson to the mouth of the river, the river consists of alternating bars and caving banks, with crossings more or less troublesome at low water, a few of the latter operating to effectually close the river to navigation, at extreme low water for even boats drawing but 2 feet of water. In all cases of this kind the crossings occur at points at which, while the river is falling from a 10-foot stage to extreme low water, its water is so widely spread that it develops no channel at any point. Six years of careful study of this river, combined with the testimony of the navigators of the river, all point to this fact, that the crossings are deep or shallow in proportion as the water is narrow or broad at or above the crossing, and that a very slight contraction, such as that produced by a few logs, tree tops, and sometimes clay lumps, just sufficient to give defining power to the current, will convert a bad crossing into a good one.

During the fiscal year ending June 30, 1891, the balance (\$2,116.60) of the contingent provided in the act of August 11, 1888, was expended in conjunction with the appropriation made by act approved September 19, 1890, in the extension of Dike 2 and repairs to Dikes 3 and 4. This closes special reports upon the Pine Bluff Reach.

To economize time and space reference is here made to the last Annual Report of the Chief of Engineers, page 1934, for conditions which relate to the above-mentioned work. This sum, with money from the appropriation of act approved September 19, 1890, extended Dike 2 200 feet, and repaired Dikes 3 and 4 by filling them to about 17 feet above low water with brush and sand boxes. It was my intention to submit

a drawing showing the changes, but the remarkable period of high water that has prevailed has prevented obtaining any satisfactory data. The same satisfactory results continue to follow the works as heretofore reported. Some attention will have to be given to the works here to keep them in repair, but this will all come under those necessary to hold a caving bend when works have been erected to improve a bar below, and as the confines of this report are limited and much space has been given to this locality during the past 4 or 5 years, it is doubtless fitting that the river generally be given this space, and all interested parties be referred to the reports of previous years. Proceeding to the other two heads where specified sums were appropriated, viz, for Dardanelle and Van Buren, it may be stated that, except visits of inspection, no work has been done at either place.

At Dardanelle the results are most gratifying. It only remains to watch developments and give fixation to the works at the proper time. The very latest advices show that the entire bar has been removed as contemplated. It will be remembered that this was pronounced as not likely to be accomplished with the money asked for. The small balance will be held for a time to watch developments. This work as a problem of river engineering is very interesting, but can scarcely be elaborated in a report like this. At Van Buren there is now no doubt but that the dike will need extending 100 feet or more. Such extension will not fill up the channel in the draw if the present results form any guide.

The problem here is a very nice one, inasmuch as there is danger of throwing a bar under the draw span of the bridge in the attempt to throw the channel against the wharf. The dike will be extended during the coming season under proper authority as a part of the general plan for the improvement of the river.

This brings this report to the improvement of the Arkansas River as a whole. Before entering upon this report attention is briefly invited to the fact that the work covers at least 710 miles of river, and there have been \$330,000 wherewith to work, where \$900,000 was asked for; or, to put it in another way, the engineer is expected to enter upon the improvement of the river with about \$470 per mile, when the least estimate calls for over \$14,000 per mile. Facing these conditions, evidently about the only thing to be done is to select the places that affect the greatest amount of commerce, and improve them as far as the sum appropriated will permit.

Acting upon this plan, during the fiscal year \$94,201.01 have been expended, as follows, viz: Two dikes, each 400 feet long, were erected in the reach above Fort Smith—i. e., from Fort Smith to 3 miles above. Two dikes about 30 miles above Fort Smith were well advanced towards completion. For this work also a new hull was built for the quarter boat *Lizette*. These works affect a great deal of commerce. Since completion the water has remained too high to determine their effects.

At Moores Rocks, about 30 miles below Fort Smith, work was begun in July excavating the channel proposed there, but had to be suspended when 260 cubic yards of rock had been removed on account of high water, and the water has remained too high ever since for the work. To economize space it may be noted here that this is an unusual condition of things and has delayed the works generally upon the river. The cofferdam is still intact, and work will be resumed whenever the water permits. Beginning about 2 miles below Pine Bluff, 5 dikes have been erected, one 450 feet long, two 800 feet long, one 807 feet, and one 1,200 feet. The above dikes are located in the blue prints* sent herewith and

* Not printed.

marked A^o, A, A₁, A₂, and B. These are the permeable dikes fully described in former reports, and always from 7 feet to 9 feet above low water, except A^o, which is carried higher at the shore end. High water prevents any report upon the results from accurate low-water survey. From general indications and the reports of pilots they are very satisfactory so far. Steps have been taken to give fixation to the work from Pine Bluff to the Rob Roy Bridge by a series of dikes and by revetting the caving bends. As this requires a survey at or near low water, progress has been delayed, as indicated, by the high water. This will be entered upon as soon as the stage of* water permits.

The dikes referred to as 5 and 6 at Pine Bluff in the early part of this report form a part of the series. They are used on account of the quicksand, the revetment being used when there is no quicksand, as required by the indorsements of the division engineer, duly approved in the office of the Chief of Engineers.

In addition to the above works ten barges, 60 feet by 20 feet, have been built, and various additions made to the machinery of the plant, and the dikes above Baring Cross Bridge, at Little Rock, have been repaired in part, to be completed early in the next fiscal year.

I am glad to be able to report a change of sentiment in regard to furnishing rock for the work, by which, with a suitable plant, I shall be able to obtain rock ballast lower than sand-box ballast, the reverse having been the case until owners of rock have seen that they had better take a reasonable price for stone than none at all.

The results of the work done in previous years in accordance with present project have all been most satisfactory wherever the dikes have been erected a sufficient length of time to do the work expected of them. The requisite depth of 2½ feet to 3 feet at extreme low water has been maintained. No bar has formed below the dikes in the channel and no caving of the banks opposite the dikes has taken place. The work of the years 1888 and 1889 above Baring Cross Bridge, at Little Rock, has continued its effective action, and the current now passes through the draw span of the bridge, as it did when the bridge was originally erected. But for the splendid work at Dardanelle this in itself might be regarded as a marked result. The contraction works below the Little Rock and Fort Smith Railway Bridge at Little Rock have demonstrated the correctness of the theory upon which they were built. This is a significant fact, as they are absolutely the only dikes built in full accord with the plan, i. e., an adequate number as called for in the plan. It will be borne in mind that in other places one or more dikes, out of a total of four or five that will be required, have been erected, because the appropriation is so small. At this point, however, a fair test has been made, with the results as stated. This reach has been known for years to be the worst reach between Little Rock and the mouth of the river. Steamboats could come within sight of Little Rock and be unable to reach the wharves on account of this reach. Two dikes were built on the 1886 appropriation and two more on the 1888, making a complete system, according to the original plan. One pilot of 20 years' standing on the Arkansas River speaks of it with the highest enthusiasm, and to him it is a most wonderful result. What has been done here can be done for any other reach on the Arkansas River. The very latest advices show that at Eagle Bend and White Bluff equally satisfactory results have been achieved. Several pages of this report might

* During the study of this river a profile has been prepared and also certain hydrographs. One tracing and two blue prints of each are inclosed for reference if required (not printed).

be occupied in speaking of the enthusiastic reports received from all the works, but this is unnecessary. Neither is it necessary now to enter into any elaborate details setting forth the proposed work. Regular plans and estimates having been prepared, this has all become a matter of printed record.

As a matter of plain duty it must be stated that prompt results are not to be expected with only \$150,000 or \$180,000 for 2 years' work, when \$1,000,000 could be profitably expended in that time.

The engineer in this way spends more time in the vain effort trying to make both ends meet than in actual engineering study or development of the works. Fully \$100,000 ought to be expended in the plant at once. There are not barges, pile drivers, and steamboats enough to do economical work. Again, material and labor is advancing very rapidly in price, and it will soon cost one-third more to do the work on this account. If anything like economical results are expected at least \$1,000,000 should be made available for the fiscal year ending June 30, 1893, and it will require \$3,472,479 to complete the improvement in accord with the original plan. This is not a fancy estimate, but close calculation, borne out by 7 years of unremitting labor. In connection with this river, I must again respectfully invite attention to the wonderful development of this State, and the natural tendency of all this to make Little Rock a great commercial center. All the statistics connected with my reports bear upon this more or less. As one reach of river under consideration has Little Rock at its head, the great importance of these works becomes more apparent. A careful study of statistics for 5 years convinces me that the State of Arkansas will, ere long, rise many files in the rank of the States, and public improvements will return manifold their cost in material benefit to the entire State.

The amount stated above as being required to complete the improvement only refers to the reach from Fort Gibson to the mouth. If the improvement is to be extended from Arkansas City, Kans., to the mouth of the river there must be added for the reach from Arkansas City, Kans., to Fort Gibson, Ind. T., \$1,696,900.

COMMERCE.

For general summary of commerce, see that under head "Removing obstructions in Arkansas River, Arkansas, Indian Territory, and Kansas."

Further details may be summarized as follows: Commencing at the head of navigation on the Arkansas River, thence following down through the fertile valley tributary to it, we have Wichita, Arkansas City, Fort Smith, Dardanelle, Little Rock, and Pine Bluff, six of the largest cities in the valley, which, together with their surrounding counties, have a population of over 400,000 inhabitants. The commercial growth and prosperity of these cities demand an outlet by way of this river. The following table, which has been compiled from statistics and letters from prominent business men of each of these cities and Territories, shows over 1,000,000 tons of freight that will be cheapened by the improvement of the Arkansas River.

	<i>Tonnage.</i>	<i>Tons.</i>
Arkansas City, Cowley County, Ark.....		429, 036
Fort Smith, Ark.....		51, 526
Dardanelle and vicinity.....		21, 850
Little Rock.....		689, 476
Pine Bluff.....		509, 828
Total.....		1, 701, 718

2042 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

In conversation with manufacturers and commission merchants we learn that the river business would be increased 50 per cent. on machinery and local merchandise freights, and on products and through freights the increase would be many times what it now is. Should the river be so improved as to admit of a regular and competitive line of steamboats it would be reasonable to suppose that in such a case freight rates would be reduced, as the rates under the existing circumstances are much lower by boat than by rail; for instance, the rates on coal from Memphis, Tenn., to Pine Bluff, Ark., is \$1.25 per ton by rail, and it has been carried for less than half that price by boat. Cotton is a product that would naturally seek an outlet by river to New Orleans and Memphis, and is carried at present 20 per cent. cheaper by boat than by rail.

If it is proposed to extend this question to Kansas as tributary to the Arkansas River, for a natural outlet for commerce, the following would figure, viz:

Tonnage of Butler, Chautauqua, Cowley, Elk, Harper, Kingman, Sedgwick, and Sumner Counties, Kans., for the years 1883 and 1884.

	Tons.
Wheat.....	183,638
Corn.....	553,509

In 1884 in these same counties more than half a million tons of old corn remained on hand, and I am informed upon reliable authority that last year there was a still greater surplus, the highest market price per bushel for corn not exceeding 15 cents, while in Little Rock and below corn has been bought for from 30 to 40 cents per bushel, cotton planters preferring to buy corn at this rate rather than to devote their valuable cotton land to raising it. Comment is unnecessary.

The following letter was received just before closing the report:

CHAMBER OF COMMERCE,
Fort Smith, Ark., June 27, 1891.

DEAR SIR: I herewith inclose your questions in regard to river business, and answers thereto. Capt. John Matthews, a good authority on such matters, suggested the answers. I am afraid the answers are not satisfactory enough because we can not back them up with figures. This is impossible, as no record of the amount of business and increase of the same has been kept. If we can render you further assistance in this important matter, command us. The chamber of commerce, and the people of Fort Smith generally appreciate the good work you are doing, and the kindly interest you have always taken in western Arkansas and Fort Smith.

I have talked with river men, lumbermen, and prominent shippers, and they all agree that the river has been greatly benefited by your work and the river business wonderfully increased thereby. The Fort Smith Merchant's Transportation Company now own two good boats, the *John Matthews*, which cost \$10,000, and the *William Druke No. 2*, which recently cost \$6,600. They ply between Webber Falls and Dardanelle. This shows that our business men have faith in the increasing river business which affords them such cheap transportation.

Yours very truly,

R. H. ADAIR,
Secretary.

Capt. H. S. TABER.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., May 29, 1891.

DEAR SIR: * * * * *

QUESTIONS AND ANSWERS.

1. How much freight was carried yearly before the river was worked by the Government?

Answer. Fifteen years ago comparatively no business was transacted on the river

on account of insufficient water and steamboat facilities. Within the last 10 years, by reason of the improvement in the channel, our steamboat facilities have increased, and the business now requires two steamboats between Webber Falls and Dardanelle.

2. If the river was so improved as to be navigable at high, medium, and low water, how much, if any, would the cost of shipping freight be reduced?

Answer. Freight would be reduced at least 100 per cent. The principal towns between Fort Gibson and Dardanelle are on the river and they would be supplied with merchandise by Fort Smith merchants and this would afford the best market that tributary country could get for its products. This would encourage competition in the steamboat business and still reduce the cost of freight.

3. If the river was so improved as stated in the recent question, would it bring the freight down any, and if so, how much?

Answer. Yes, it would greatly reduce freight. The reduction would be from 50 to 100 per cent.

4. How much more freight of different kinds would be shipped every year if the river was improved as suggested in the second question?

Answer. The business would increase rapidly and to such an extent that it would be hard to even estimate it. The thousands of acres of rich valley lands that are now unimproved on account of the cost of getting its produce to market would be brought under a high state of cultivation at once. New towns would spring up along the river, and our present line of steamers would soon be inadequate to do the work.

5. Are there any other ways in which the people of your town, county, or section would be benefited? If so, please name them.

Answer. It would aid materially in opening up a tributary country to Fort Smith that is rich in minerals, coal, and timber, as well as in agriculture, and whose business would be of incalculable value. This country is now practically cut off by reason of the great expense of getting to market. There is no richer country than the Arkansas Valley, and the question of transportation is what interests the people more than anything else.

Mr. R. H. ADAIR,

*Secretary Chamber of Commerce,
Fort Smith, Ark.*

Money statement.

July 1, 1890, balance unexpended	\$71, 295. 42
Amount appropriated by act approved September 19, 1890.....	180, 000. 00
	<hr/>
	251, 295. 42
June 30, 1891, amount expended during fiscal year.....	94, 194. 61
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July 1, 1891, balance unexpended.....	157, 100. 81
July 1, 1891, outstanding liabilities	3, 774. 80
	<hr/>
July 1, 1891, balance available	153, 326. 01
	<hr/>
{ Amount (estimated) required for completion of existing project.....	3, 472, 479. 00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	1, 000, 000. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Expense account.

Pay rolls	\$50, 319. 16
Subsistence supplies	11, 163. 66
General supplies	25, 199. 53
Transportation	443. 46
Traveling expenses	809. 04
Fuel.....	2, 575. 58
Stationery.....	135. 15
Rent	120. 00
Lumber	2, 921. 03
Reserved in United States Treasury for freight charges	208. 00
Reserved in office of Chief of Engineers.....	300. 00
	<hr/>
	94, 194. 61

W 3.

IMPROVEMENT OF FOURCHÉ LE FEVRE RIVER, ARKANSAS.

The improvement of this stream was begun in 1879, under the act approved March 3, 1879. Prior to any improvement its channel was choked with snags, logs, and drifts, and heavy timber overhung its banks. Several bad shoals also impeded navigation. Up to June 30, 1886, \$21,000 had been expended in removing the greater part of the obstructions, though the shoals, and now and then a snag that has washed in since work was suspended in December, 1882, still offer serious obstacles to navigation at medium stages of water. By act approved August 5, 1886, \$5,000 were appropriated for removing rock shoals situated about 4 miles below Perryville. At the close of the fiscal year ending June 30, 1888, this sum had been expended, completing a channel about 500 yards long, 30 feet wide, and 2 feet deep at low water through this shoal. By act approved September 19, 1890, \$7,500 were appropriated for this work. From June 30, 1888, to September 19, 1890, no appropriations were made for this work.

During the fiscal year ending June 30, 1891, \$2,448.70 was expended in building a hand-propelled light-draft snag boat after the *A. B. Johnson* model, which has been found to be so well adapted to streams of this size. It draws but 13 inches of water with its powerful machinery on board and fully equipped with rations and crew, and can reach every low-water snag that can possibly interfere with the packets, none of which draw less than 16 or 18 inches of water.

By act approved September 19, 1890, \$7,500 were appropriated. The approved project for its expenditure provides for the building and equipping of a hand-propelled snag boat of the *A. B. Johnson* model, at a cost not to exceed \$4,000; that it be operated for 4 months, if possible and necessary, at or near extreme low water, in removing accumulated obstructions in the way of snags, logs, and drift piles, and also land slides, and certain boulders on Piney Shoals, and \$450 to be expended in making a square section through May Shoal in the place of the present reversed arch, which will not permit a square-bowed flatboat to pass and take out a portion of a rock at Red Ferry, which lies like a whale's back, and offers a very narrow channel to steamboats. All this to provide for high and medium stage navigation; low-water navigation is out of the question, except, say, for 26 miles from its mouth to Piney Shoals.

This boat is to be operated only at or near extreme low water. During the year no such water occurred. The boat is in readiness for the field, and operations will be begun as soon as the water reaches a suitable stage. There will be some advantage to this river in this delay on account of the water, inasmuch as some of the old and experienced men will be available during the coming fiscal year that might not have been available during the past. It is hardly necessary to again refer to the fact that these boats have accomplished wonderful results in these narrow streams for the amount of money expended, and most careful attention will be given to the operation of this boat, that the record may be sustained. It is believed that the present appropriation will meet the present demands of the commerce upon this river. It is doubtful if there is any more deserving stream for its size in the district. Its opening will afford great relief to a community practically without transportation. For further facts in this line see the report under the head of commerce.

COMMERCE.

The amount of commerce when work of improvement began may be inferred from the following, which appeared in the Annual Report of the Chief of Engineers, page 971.

The valley of the Fourche Le Fevre is one of the most extensive in the State. Large quantities of lumber and cotton are brought out annually, besides grain, furs, tallow, and beeswax. There are also mines of lead, iron, and other metals in the valley which can be profitably worked when the improvement is completed.

As to the effect upon rates of insurance and freight, no data to work from. The incomplete state of the works would be against any great change. As to effect upon competing routes of transportation, there are no competing routes. What freight the steamboats do not succeed in reaching must be hauled long distances in wagons.

As to prospective advantages to commerce if completed, with this river thoroughly improved there would be a great saving of time to shippers. It would reduce the cost of transportation to that extent that new impetus would be given to the settlement of the country and largely increase its products. As to the benefits to community if completed, there are few communities in this State so dependent on a river for transportation as the settlers of this valley. Every step in the improvement will bring direct gains and will be utilized at once. With such improvements as have already been made, over 3,000 bales of cotton are brought out annually and several tons of freight are handled. One steamboat works very energetically upon this river and takes immediate advantage of every improvement, so that the people are sure of immediate relief as the channel is improved.

Money statement.

Amount appropriated by act approved September 19, 1890	\$7,500.00
June 30, 1891, amount expended during fiscal year	2,448.70
July 1, 1891, balance unexpended	5,051.30
July 1, 1891, outstanding liabilities	330.28
July 1, 1891, balance available	4,721.02

Expense account.

Pay rolls	\$963.41
Subsistence supplies	35.62
General supplies	921.98
Traveling expenses	30.80
Stationery	16.89
Rent	80.00
Machinery	400.00
	2,448.70

Tonnage of Fourche River, Arkansas, 1,000 tons.

W 4.

IMPROVEMENT OF PETIT JEAN RIVER, ARKANSAS.

Before improvement this river was obstructed with snags, logs, drift-piles, overhanging trees, and shoals. The original project for improvement contemplated rendering it navigable during high and medium stages of water as high as Danville, Ark., by cutting the overhanging trees and cutting up the snags, logs, and drift. The fall in the river is so great that nothing could be done to improve the shoals. The first appropriation ever made for the river was that of the act approved August 5, 1886, amounting to \$3,500; one-half the estimate, \$7,000. This amount was expended prior to June 30, 1888, in completing the work of improvement to Rocky Crossing, or about one-half the distance. The act, which became a law August 11, 1888, appropriated \$2,500 and provides for continuing the improvement below the Iron Bridge at Rocky Crossing. It will be seen that this is a departure from the original project, and contemplates entering upon an improvement of a semi-permanent character. This reach of river was accordingly visited in person and a new project prepared and duly approved. This project provides that \$2,500 be expended below Rocky Crossing in removing timber from the low-water channel and in removing a small portion of the ledges at Slaty Crossing and Robinson Ridge, so as to prolong the season of navigation. The best season for conducting this work begins about the middle of August or the 1st of September. The date at which the act became a law precluded the possibility of making the examination, preparing the project, and commencing the work during the fiscal year ending June 30, 1889, as high water would have interrupted the work before it would have been completed, rendering suspension of work necessary, thereby adding materially to the expense of transporting men and material to the works on two different occasions, when one would answer as well. For these reasons no work except that necessary to make the examination had been done during the fiscal year ending June 30, 1889.

The fiscal year ending June 30, 1890, was prolific in sudden rises, and there was no time, on account of these unusual conditions, when the work necessary to be done could be planned with any certainty of being completed, and as much complaint had been made about money being expended at high water, it was thought best to hold this money until a regular prolonged low-water season would permit its expenditure to the very best advantage possible. Accordingly, in the fiscal year ending June 30, 1891, a completely organized force was placed in the field and the balance expended in accordance with the project. The amount of work done for the money reflects great credit upon the overseer, Mr. S. L. Titus, and may be recapitulated as follows: Trees cut, 2,558; trees deadened, 1,521; snags and stumps removed, 599; cubic yards of rock and gravel excavated, 340; distance worked over, 21 miles.

It is scarcely necessary to prolong this report to state the advantages to be derived from the improvement, since these are set forth at length in the remarks in reference to commerce. It is my duty as engineer officer in charge to renew the recommendations of improving the river from Rocky Crossing to Danville, Ark., according to the original project.

Thirty-five hundred dollars will be required for this purpose. In this connection attention is respectfully invited to my reports of the last 2 years. The entire river to Danville will some day be a valuable artery

of commerce, and the bridge to Rocky Crossing, which now obstructs its free and safe navigation, should be made to comply with the law at as early a date as possible.

COMMERCE.

When works of improvement began a boat made 2 or 3 trips a year, at high water or medium stages, and brought out from 200 to 300 bales of cotton. With the improvement completed, freight rates would be reduced 50 per cent. and distance in hauling by wagons reduced 26 miles. There being no competing routes of transportation, except wagons, no comparison of rates can be made. The completion of the works as originally recommended would increase the commerce tenfold, and it is estimated by one writer that from 5,000 to 6,000 bales of cotton would be moved by river. Another writer estimates the increase at from 50 to 100 per cent. The community generally would receive many benefits. One writer estimates that products could be marketed at one-half present cost; another states, as an incidental benefit, that the freeing of the river of obstructions will reduce the overflow, thereby increasing the areas under cultivation and improving the general health of the section. To all this may be added the fact that this stream is the only outlet to the Petit Jean Valley. This valley is very rich. The town of Danville, in this valley, receives over 1,000 tons of freight annually by wagons. Timber is plentiful and in great variety. The great drawback to this section is its want of cheap transportation. The opening of the Petit Jean to navigation for 5 or 6 months would be of untold value to the entire valley. The limits of a report of this kind forbids entering into details, but it may be stated in a general way that the total required to complete the work is insignificant compared with the results to be gained.

Money statement.

July 1, 1890, balance unexpended	\$2, 444. 52
June 30, 1891, amount expended during fiscal year	2, 444. 52
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{ Amount (estimated) required for completion of existing project	3, 500. 00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	3, 500. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Expense account.

Pay rolls	\$1, 590. 30
Subsistence supplies	268. 87
General supplies	419. 44
Transportation	47. 79
Traveling expenses	51. 10
Stationery	36. 80
Rent	40. 00
Returned to U. S. Treasury for freight charges .....	. 22

2, 444. 52

Tonnage of Petit Jean River, Arkansas, 1,500 tons.

W 5.

IMPROVEMENT OF WHITE RIVER, ARKANSAS.

Prior to improvement this river was much choked with snags, drift piles, and logs in its lower portion, and from Batesville up gravel bars, rocky shoals, channel boulders, and overhanging trees impeded navigation. The originally adopted project consisted in snagging operations, blasting of ledges and boulders, and dam building to remove gravel bars, or to close chutes from time to time, as appropriation warranted and commerce required.

The first separate appropriation for this river was made by act approved July 5, 1884. At the time it was passed the river was in excellent navigable condition for boats drawing not to exceed 3 feet of water from its mouth to Newport, Ark. From Newport to Batesville there were many troublesome snags, and from Batesville to Buffalo Shoals there were numerous bad shoals, rendering navigation very uncertain. From Buffalo Shoals to Forsythe, Mo., there were many fine reaches of river, but the depth of water on Buffalo Shoals and others, less dangerous, prevented any navigation at ordinary stages of water. This river has been united so often with the St. Francis, and again, once with the Black and St. Francis and once with the Black and Little Red, that it is impossible to give exactly how much had been expended upon the White River to June 30, 1884. After a careful study of House Ex. Doc., No. 64, Forty-eighth Congress, first session, the approximate amount is set down as not under \$170,000 and not over \$200,000. This estimate should be given a weight of 8 in a scale of 10. The project for expending the appropriations made by acts of July 5, 1884, August 5, 1886, and August 11, 1888, provided for the removal of snags, boulders, and other obstructions to navigation, building wing dams to improve shoals, repairs to and care of plant, and survey of river as provided for in the acts, with a view to its permanent improvement, from Forsythe, Mo., to its mouth. Up to June 30, 1890, \$71,484.35 had been expended. This completed the survey, plotted the notes, published the maps, and effectually improved some of the most dangerous shoals between Buffalo Shoals and Batesville, gave much relief to navigation by removing the most dangerous snags from Batesville to the mouth of the river, constructed and equipped 6 barges, one floating pile-driver, cared for the property, and partly completed a dike at Newport.

During the fiscal year ending June 30, 1891, \$16,506.39 have been expended in a careful work of improvement upon the shoals, beginning at Mount Olive and working to Batesville. A few snags and overhanging trees were removed by the tow-boat (which carries snagging appliances) wherever such work was required. The unusual high water prevented the completion of the dike at Newport.

In November, 1890, a little work was done there, but had to be immediately suspended on account of high water.

The following shoals were improved, viz: Porter, Hodges, Wild Haws, Earnhardt, and Batesville, the latter being not quite completed at close of fiscal year. To accomplish this 1,460 linear feet of dams were built and 11 cubic yards of rock were removed from the channel. The work extended over 47 miles of river.

From data secured the zero of the gauge as fixed in the vicinity of Buffalo City, Ark., is unquestionably still five-tenths foot too high, the oldest inhabitant being in error in his statement to the surveying party something like 1.5 feet. Much relief has been afforded navigation, but the depth of 2 feet has not been attained at low water on ac-

count of this error in the fixation of the zero. A much larger sum of money will be required to complete this improvement, inasmuch as by actual and careful observation low-water mark is nearly as much below the best that could be determined from the inhabitants of this new country as the depth of water originally contemplated to be given a channel over this reach of river. From this fact a new set of conditions arise.

During such time as I have been able to take from the conduct of the works during the past season, since I have become certain of the above-mentioned fact, much study has been given to the course to be pursued. The present plans and estimates are of course entirely inadequate so far as the river from Newport, Ark., to Forsythe, Mo., is concerned. The demands of commerce are becoming very clamorous, and after careful deliberation I am of the opinion that the question of a system of locks and dams ought to be canvassed at once and a beginning made upon an improvement of this nature. There are quite a number of shoals that will need locks and dams to overcome them. No estimate can be furnished of the cost of these locks and dams without a more complete survey of the localities. The most judicious plan that has occurred to me would be to recommend an appropriation of \$75,000 or perhaps \$100,000, \$50,000 to \$75,000 of which to be expended at the shoals not requiring the system of locks and dams, and the balance, or so much as might be necessary, utilized in making detailed surveys preparatory to furnishing plans and estimates for a system of locks and dams: this outside of the \$53,815 required to complete the existing project, which should be used almost entirely between Newport, Ark., and the mouth of the river, in accordance with the plans and estimates that are already a matter of printed record. This would make the total that could be profitably expended during the fiscal year ending June 30, 1893, \$153,815.

Attention is respectfully invited to the increase in the tonnage of the river and to my statement made in the original plans and estimates submitted several years ago, that in my opinion the time would come when the vast commerce of this territory would demand the application of a lock and dam system to this river.

I am satisfied that as yet the full tonnage of this valley has not been secured, although this people are now thoroughly awake as to the necessity for cheap transportation. It may be noted here as applicable to all my annual reports that, while charged with a vast territory, well watered with navigable streams, the people inhabiting the territory are so little conscious of the resources they possess in their fertile fields, timbered hills, mineral-stocked mountains, and natural water ways, that it is only by the most strenuous efforts that anything like an accurate showing of commerce can be obtained. A quick way to get attention to this White River would be to say that it has at least all the possibilities of the Tennessee River, with a margin in its favor, if anything.

COMMERCE.

The first appropriation having been made in 1833, the records of this office do not show what was the amount of commerce prior to any attempts at improvements.

In the Annual Report of the Chief of Engineers for 1876, page 627, Colonel Suter, referring to the upper reaches of this river, says:

The country bordering on this portion of White River is almost entirely dependent upon water transportation, which from the difficult character of the navigation is very uncertain and costly.

And even one year later he speaks of much of the commerce being carried on by teams. (Annual Report Chief of Engineers, 1877, page 501.)

The advantages to commerce if the permanent improvement is effected will be greatest of that to any river in the State in proportion to the cost. This is a natural highway for commerce to an extensive territory, and much of this territory has as yet no other outlet except the wagon. In this connection see Annual Report Chief of Engineers, 1880, page 1313; Annual Report Chief of Engineers, 1884, page 1401; also, Annual Report Chief of Engineers, 1885, pages 1589 and 1591. Here will be found a steady increase in commerce, keeping pace with the improvements, which speaks for itself and calls for no comment. As to benefits to community, it may be said that a community that will follow up the work already done as this one has can but be greatly benefited. Every improvement made is promptly taken advantage of. The rapid growth in prosperity in this section warrants the belief that the permanent improvement of this river will confer benefits upon this community so great that the cost of the works will seem too small for comparison. Anyone taking the trouble to read the Annual Reports of the Chief of Engineers for the past 12 years will be struck by the uniform testimony of engineers in regard to the future great commerce of this river, a significant fact in itself.

Data gathered from various sources may be condensed as follows:

There is a division in the commerce of this river, the Upper and Lower White, both territories improving rapidly under the present system of river improvements. The Upper White River territory, which needed principally a low-water channel by improvement of shoals to insure a regular transportation of products, is beginning to show a marked improvement in agricultural lands, especially near the river, and yielding a greater tonnage each year. These products, which have been hauled heretofore across the country in wagons from 50 to 80 miles to Springfield and other points on the railroad that lead to St. Louis markets, are beginning to find a more accessible outlet by way of the river to Batesville and Newport, where they are transferred to the railroad and carried to the same market. The ultimate results of this river improvement will not only be a settlement of the country, but also a creation of new markets in the direction of New Orleans, to where a cheaper transportation is offered by way of the river. The mining enterprise is also being engaged in all along the Upper White River, and a greater demand for river navigation is presenting itself to the community in general. During the past year, in developing these mines, several barge loads of zinc ore were shipped down the river at a comparatively low stage of water, the obstructions being so greatly reduced by the river improvement that it was found possible to ship in this way.

A number of enterprising citizens have responded to the inquiry for commercial statistics of this river during the past year, and all agree that the improvement is of vast importance to the enhancement of products and settlement of the country.

A tabulated statement from Capt. Charles B. Woodbury gives the traffic in cedar and lumber as 54,960 tons, against 26,200 tons last year; also 3,878 tons cotton against 2,825 tons last year.

This is an increase of over 100 per cent. in lumber and 37 per cent. increase on cotton, the staple product of this country.

The tonnage of Lower White River has decreased somewhat, owing

to better railway facilities and a decrease in the products of the overflowed territory below Clarendon.

Tonnage during the past year.

	Total freight.
Upper White River.....	<i>Tons.</i> 113,085
Lower White River.....	38,496
Total.....	151,581

Money statement.

July 1, 1890, balance unexpended.....	\$1,532.26
Amount appropriated by act approved September 19, 1890.....	30,000.00
	31,532.26
June 30, 1891, amount expended during fiscal year.....	16,505.85
July 1, 1891, balance unexpended.....	15,026.41
July 1, 1891, outstanding liabilities.....	1,525.50
July 1, 1891, balance available.....	13,500.91
{ Amount (estimated) required for completion of existing project.....	153,815.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893.....	153,815.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Expense account, improving White River, Arkansas.

Pay rolls.....	\$12,278.13
Subsistence supplies.....	2,074.65
General supplies.....	1,272.91
Transportation.....	40.19
Traveling expenses.....	292.45
Fuel.....	397.86
Stationery.....	23.55
Rent.....	80.00
Lumber.....	39.06
	16,498.80
Reserved in United States Treasury for freight charges.....	7.05
	16,505.85

W 6.

IMPROVEMENT OF CACHE RIVER, ARKANSAS.

made for this reach of river became available this time the channel was choked with trees interfered with smokestacks, and severely interfered with navigation. The project proposes the removing of the hanging trees from the town of River View. This operation will incidentally remove the obstructions which are caused in the majority of cases by an

accumulation of logs. Seven thousand dollars was the amount appropriated, \$3,000 for the construction of a snag boat and \$4,000 for the operating expenses, working at or near extreme low water, the boat being constructed of light draft for this purpose.

Up to June 30, 1890, the entire sum except \$7.11 had been expended. The snag boat was built and operated as far down as Walkers Ferry, leaving 35 miles of river yet to be worked. The boat was operated just as near low water as it could be moved and with a draft of only 14 inches. It will be seen that only the main channel could be worked, as it surely could be found at the low-water stage. The obstructions encountered were more formidable than the reconnaissance showed, one snag when lifted often bringing up several others. The balance of the river could be cleared by selling the snag boat to some other appropriation, but as these other appropriations were small it could not be done during the fiscal year ending June 30, 1891. The boat has been well cared for and kept in thorough repair and used upon the Black River. If an adequate appropriation is made for the Black River, Arkansas, the boat might be sold to that river and the proceeds worked out in her operating expenses upon this river and no further appropriation made for this particular river. If, however, the Black River appropriations are less than \$12,000 then public policy would require the appropriation of at least \$3,000 to complete this work. The remarks under commerce are all that is necessary to show what a large amount is to be benefited.

COMMERCE.

It is not easy to ascertain the amount of commerce upon this river prior to the making of this its first appropriation. Since the building of the railroad the many obstructions in the stream have caused boats to give up the use of it, and it is hard to get any information in regard to it. It could not have been large, for the obstructions are so numerous as to preclude much use of it. As to the effect upon insurance and freight rates this can only be known by actual trial, as this is almost a hitherto unknown river so far as any records go.

As to the effect upon competing routes of transportation, there are probably very few sections in which an open river would afford relief to a burdened people under exorbitant rates made by a single line of railroad as this one will do. As to relative cheapness there, of course, can be no question as to water *versus* rail transportation. Reliable parties state that the opening of the river will cause a market reduction in freight rates.

As to prospective advantages to commerce there is at present no computing them. The timber alone warrants the present outlay. The country is very fertile, well adapted to cotton, corn, fruit, and grain, easily cultivated, and only one-fourth settled, and it is as difficult to predict what the prospective advantages to commerce will be as to have taken up 50 or 75 years ago and predicted the commerce upon some similar streams in older States, where thousands and even millions of dollars of freight are now transported annually. The river is really almost a natural canal, and it is believed that 50 years from now will see it provided with a few locks and so used.

During the month ending June 16, 1890, 2,762 tons of lumber were rafted through the bridge of the Memphis and Little Rock Railway. This is the first month of systematic effort to secure the tonnage of the river.

Money statement.

July 1, 1890, balance unexpended.....	\$7. 11
June 30, 1891, amount expended during fiscal year.....	7. 11
<hr/>	
{ Amount (estimated) required for completion of existing project.....	3, 000. 00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	3, 000. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Expense account.

Stationery supplies	\$7. 11
Tonnage of Cache River, Arkansas, 30,000 tons.	

W 7.

IMPROVEMENT OF LITTLE RED RIVER, ARKANSAS.

The first improvements attempted upon this river were made in the year ending June 30, 1872, under the act approved March 3, 1871.

Prior to this work many overhanging trees interfered with navigation in the lower reaches, and many bowlders obstructed flatboat and raft navigation in the reach above the present town of Judsonia. The appropriation referred to above was for the White, Black, and Little Red Rivers, and amounted to \$10,000 for the three, upon estimates amounting to \$259,033, of which \$38,065 were for the Little Red River. That little work could be done is apparent from Colonel Reynolds's report for 1872, in which he states:

Unless other and better facilities are provided it will be of very little use to attempt to remove the obstructions in such streams as these.

Most of the overhanging trees were removed as high as Judsonia. A bad shoal 3 miles below Judsonia and the bowlders remained untouched to the end of June, 1886. The act approved August 5, 1886, appropriated \$3,000. The present project contemplates the removal of the dangerous bowlders above Judsonia and a shoal 3 miles below the same town. Up to June 30, 1888, \$612.90 had been expended in removing the bowlders above Judsonia and the care of the property and records. By the act which became a law August 11, 1888, the balance, \$5,400, necessary to carry out the original project was appropriated. During the fiscal year ending June 30, 1889, \$5,008.90 was expended in the construction of the dredge to be used in removing the shoals 3 miles below Judsonia and in the construction of two material barges. During the low-water season of the fiscal year ending June 30, 1890, \$1,531.53 was expended in dredging the shoal 3 miles below Judsonia, known as Bess Shoal. These shoals are composed of two reefs about three-fourths of a mile from lower to upper edges. The upper reef has been finished to a depth of 1.1 feet below low water and 30 feet wide, and about 285 tons of broken rock and gravel removed. Some very effective work was done at the lower reef, but, owing to delays from high water, only 210 tons of broken rock and gravel have been removed, making 495 tons altogether up to June 30, 1890.

Effective work at the above shoal can only be done at low water.

During the fiscal year ending June 30, 1891, the water remained so high that, except a few days in the latter part of August, no work could be done at the shoals. The dredge being required for the Arkansas River works it was sold to that appropriation, upon proper authority, for \$3,500. As this would not all be required to complete the work at the shoals, a project was prepared in this office and approved by the Chief of Engineers for expending \$1,000 of the above in cutting timber and removing stumps from the channel as high as the vicinity of Heber, Ark., so as to aid raftsmen.

In accord with this plan, during January, February, and March a party was put into camp and, with this \$1,000, cut 3,331 trees and some 100 cords of brush, opening a good channel to Judsonia, from Heber, Ark. As soon as this was done a small steamboat was placed upon the river, and many encomiums were pronounced upon the immense good accomplished.

Many trees still overhang the eddies, and as soon as the work at Bess Shoals has been completed a project will be submitted for expending all that can be saved, in farther opening this reach. All this may be done as early in the next fiscal year as the water will permit.

• COMMERCE.

Amount of commerce when work of improvement began may be inferred from the following, which appeared in the Annual Report of the Chief of Engineers, 1871, page 362:

The fact stated that the commerce of this stream is sufficient to induce the comparatively large boats running on the White River to navigate it whenever it is practicable, and when this is not the case a small steamer is kept to ply between West Point and the mouth of the River, shows the importance of the interests involved.

As to prospective advantages to commerce if completed, if the shoals known as Bess Shoals were removed so that a boat could reach Judsonia at all stages of the river, from 1,000 to 1,500 bales of cotton and about 400 tons of merchandise would be shipped by river at once. A packet drawing $3\frac{1}{2}$ feet of water now makes regular trips the year round to a point just below these shoals. The country round about Judsonia has been visited in person, and I find its resources have only begun to be developed. I should say that the present commerce would double itself in 5 years.

As to benefits to community if completed, it is hard to estimate the benefits that cheap transportation would give to a community that has known only a railroad outlet, and only one at that. No one will question but what they will be very great; how great can only be told by recalling what such transportation has done for other fertile sections; but it may safely be said that the benefits will be so great that the outlay will sink into utter insignificance.

This stream is located in a very prosperous section of the State. The present commerce amounts to upwards of 13,500 bales of cotton and 4,700 tons of merchandise. A great deal of fruit is being raised, and the amount is rapidly increasing each year. The returns will be immediate.

Money statement.

July 1, 1890, balance unexpended.....	\$537.86
Received by sale of dredge-boat, as per letter of Chief of Engineers, dated August 19, 1890	3,500.00
	<hr/> 4,037.86
June 30, 1891, amount expended during fiscal year	2,140.92
	<hr/>
July 1, 1891, balance unexpended.....	1,896.94
July 1, 1891, outstanding liabilities.....	75.00
	<hr/>
July 1, 1891, balance available	1,821.94

Expense account.

Pay rolls.....	\$1,709.21
Subsistence supplies.....	135.32
General supplies.....	193.91
Transportation.....	16.05
Traveling expenses.....	32.53
Fuel.....	45.85
Stationery	8.05
	<hr/>
	2,140.92

Tonnage of Little Red River, Arkansas.

Cotton, 13,500 bales	Tons. 3,375
Merchandise.....	4,700
	<hr/>
Total	8,075

W 8.

IMPROVEMENT OF BLACK RIVER, ARKANSAS AND MISSOURI.

Before any improvements were made upon this river, the magnificent timber which lines its banks, overhung its narrow and deep channel, giants of the forests stretched across it from bank to bank in falling, debris from logging camps lodged in the same, producing shoals, all of which presented a formidable array of obstacles, not only to navigation, but to any attempts at improving the same. The original plan for its improvement contemplated the removal of the obstructions and the improvement of the shoals, the latter by wing dams. A few sloughs were to be closed, so as to confine the water to the main channel. The work has been steadily carried forward, with very small appropriations, at irregular intervals, for upwards of 14 years. In the earlier operations the appliances were not adapted to the heavy work on hand. In later years, suitable appliances having been secured, more rapid progress has been made. Its channel being narrow, water deep, and banks firm, it is one of the most satisfactory streams in this district to improve.

Up to June 30, 1890, \$61,242.40 had been expended in carrying out the above plan, giving a very good river from the mouth up to the mouth of Current River, doing but little for the reach between the mouth of Current River and the bridge at Corning, Ark., and making a visible impression upon the formidable obstructions between the Arkansas State line and Poplar Bluff, Mo., in conjunction with the appropriation under the heading "Improving Black River, Missouri." By act ap-

proved September 19, 1890, \$5,000 were appropriated out of the \$26,000 recommended as the amount that could be profitably expended during the fiscal year ending June 30, 1891.

As stated in my last annual report, the snagboat belonging to this river was found to be in too rotten a condition for snagging operations. Fortunately a new boat built for the Cache River was idle. This boat is specially adapted for work in narrow streams. It was transferred at once to this stream on proper authority, and work begun at Poplar Bluff, Mo., under the appropriation "Improving Black River, Missouri," with a view to working down to the Arkansas State line on that appropriation and then beginning work under this head. About the time that the work was brought down to the State line and the boat had been transferred to this appropriation, the river rose, and from that time to the end of the fiscal year remained too high for effective snagging operations. During the fiscal year ending June 30, 1891, therefore, only \$1,537.28 have been expended in the necessary repairs to the plant and care of property. Early in June the boat will be put in the field and operated between Corning, Ark., and the mouth of Current River, a reach that never has been thoroughly worked. As the Cache River snagboat may be required again upon her own river, I will renew my recommendations made last year in regard to building a new hull for the snag boat *Henry Sheldon*, and transferring her upper works at a cost of about \$8,000. It seems like a redundancy to reiterate facts that have so often appeared in my annual reports, in regard to the great benefits to be conferred by the opening of this river and to the deserving character of the stream, on account of its deep water and permanent banks; yet, as I come to know this stream more and more thoroughly from year to year, I am more convinced that the recommendations made in the past should not only be renewed, but emphasized in their renewal.

My plan has been to secure an annual contingent of \$8,000 for this work, but this has been departed from so far in the amounts of the appropriations that nothing less than \$42,000 would adequately meet the requirements of the situation. It may be stated that with the expenditure of this sum as a whole, a magnificent artery of commerce would be effectively opened, which would need but very little attention for its maintenance. The work of the coming season between Corning, Ark., and the mouth of the Current River will reduce the number of snags that are likely to lodge between Current River and the mouth of the river fully 50 per cent.

COMMERCE.

The amount of commerce when work of improvement began may be inferred from the following statement taken from Annual Report Chief of Engineers, 1880, page 1326.

From the Upper Black great quantities of staves are taken, and from the Lower Black it is estimated that from 10,000 to 12,000 bales of cotton are shipped to Memphis and other markets, and other shipments (amount not known) go over the St. Louis and Iron Mountain to St. Louis.

As to effect upon rates of insurance and freight, insurance companies have not acted upon the matter. It is expected that the rates will be reduced. The work is just beginning to tell upon the freight, and it is too soon to state definitely as to rates. One man, representing a large stave factory at Poplar Bluff, Mo., estimates that rates would be reduced one-half.

As to effect upon rates of competing routes of transportation, this river parallels the St. Louis, Iron Mountain and Southern Railroad for 100 miles. There can be no question as to water versus rail transportation. Reliable parties state that the effect will be marked. As to prospective advantages to commerce if completed, freight would be increased tenfold. There is a vast tract of land through which Black River runs, the products of which must be transported by river. The country is only just beginning to be opened up, and is susceptible practically of unlimited development. It is difficult to estimate the benefits to the community if completed. This river is one of the deepest in the State. As a natural highway it surpasses the Arkansas River. Its banks cave but little, and when the standing timber has been cleared off so that snags do not accumulate it will not give much trouble as a navigable stream. It is destined to become in the near future a part of a great parallel transportation line to New Orleans, competing with the Missouri Pacific system of railroads for the traffic of an immense territory. The confines of such a report as this are too limited to do justice to this river. Were they more extended I doubt if it were possible to forecast the great benefits that will flow from its maintenance as a navigable stream.

The following letter explains itself:

F. G. OXLEY STAVE COMPANY,
Poplar Bluff, Mo., June 10, 1891.

DEAR SIR: * * * We find we have hauled on our boats during the past year 3,200 tons of freight. This freight was delivered at Poplar Bluff from points down the river, and at the railway bridge between Corning and Knobel from points both above and below the bridge. There has been taken from points above the State line three large barges of staves down the Black River into the White, and from thence to New Orleans. This could not have been accomplished prior to the last work done by your force.

I desire to compliment you on the work done by the last appropriation. I believe that I am not overdoing it when I say that it did more good than all the other work that has been done on the river combined. It is hard to tell the amount of freight which could be moved on this river, provided it could be made navigable the year round. The river has no bad bars. I think that there are only four or five places between Poplar Bluff and the State line which would require any dredging, and I believe that if all the snags were removed from the river, and the Dan River effectually closed up at its head, that these bars would all be removed by the current of the river, as it naturally has a pretty stiff current. If it could be possible to thoroughly clean this river, thus making it reasonable for a steamboat man to have water the greater part of the year, arrangements could be made to run boats continually, and as soon as settlers and people came into this country and find that they can depend upon transportation for their products, then the lower country between this and the State line would naturally settle up. Every settler would of course have some product to carry. It is of vast importance to a very large territory (I should think about 100,000 acres) that this river be thoroughly cleaned. All the overhanging trees, whether they obstruct navigation or not, should be removed, because they eventually fall into the river. Our steamboats have removed since your crew was here as many as 25 trees which fell into the river owing to washing of the banks.

This country is greatly improving, and I notice on my trips down the river a new house or a new clearing which did not appear when I was down the previous time.

I sincerely hope you will be able to secure a good round appropriation this year. If we could run our boats the year round we could double in the next year the tonnage of the previous year.

If this information is not sufficient, kindly tell me just what you want, and if it is possible to procure it for you I will cheerfully submit it.

Yours truly,

H. D. WILLIAMS,
Secretary and Treasurer.

Capt. H. S. TABER.

2058 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Money statement.

Amount appropriated by act approved September 19, 1890.....	\$5,000.00
June 30, 1891, amount expended during fiscal year	1,537.28
July 1, 1891, balance unexpended.....	3,462.25
July 1, 1891, outstanding liabilities.....	177.25
July 1, 1891, balance available.....	3,285.47
{ Amount (estimated) required for completion of existing project	42,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	42,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Expense account.

Pay rolls.....	\$851.44
Subsistence supplies.....	154.00
General supplies.....	189.96
Traveling expenses.....	31.88
Machinery.....	310.00
	1,537.28

Tonnage of Black River, Arkansas and Missouri, 97,720 tons.

W 9.

IMPROVEMENT OF BLACK RIVER, MISSOURI.

The first improvements attempted upon this reach of river were made in the years 1881 and 1882.

Prior to this work its channel was choked with logs and snags, and obstructed by overhanging trees, and in many places shoals interfered with its navigation at low water by any but very light-draft boats. Its banks caved but little, and except at the shoals it is characterized by greater depth of water than is found in streams generally in its vicinity, due to its being narrow and its banks firm. The original plan for its improvement contemplated the removal of the obstructions and the improvement of the shoals, the latter by wing dams. A few sloughs were to be closed up so as to confine the water to the main channel. Up to June 30, 1888, \$6,000 had been expended, which had opened up about 20 miles of river from Poplar Bluff, Mo., toward the mouth. Owing to the difficulty in getting suitable appliances up to this reach it was carried on under great difficulties. During the fiscal year ending June 30, 1889, the snag boat *Henry Sheldon*, specially constructed for work on this river, was successfully pushed through to Poplar Bluff and operated from there down the river, rapidly and effectively clearing the same of obstructions. Six thousand five hundred and sixty-two dollars and thirty cents were expended in the work; erecting a strong dam at the head of Dan River (a chute of the Black River); removing 293 snags; cutting 1,874 overhanging trees; deadening 17,490 trees and removing 12 masses of driftwood; carrying the work to the Arkansas State line; removing the greater portion of the dangerous low-water snags, and making a good beginning upon the overhanging timber.

During the fiscal year ending June 30, 1890, only \$199.20 was available, and this was expended in connection with the other appropriation for this river, in the running expenses of the snag boat *Henry Sheldon*.

During the fiscal year ending June 30, 1891, \$3,914.21 were expended between Poplar Bluff, Mo., and the Arkansas State line, removing 406 snags, destroying 23 piles of drift, and cutting 10,450 overhanging trees. This work was done between November 22, 1890, and February 1, 1891.

During the balance of the fiscal year the water has been too high for effective operations. This work has greatly improved this reach of river, as one of the light-draft boats transferred from the Cache River was operated. There is still overhanging timber that should be removed and many snags and logs. Good progress, however, is now being made toward the thorough opening of the river, and the balance will be expended removing the obstructions enumerated and in rebuilding the dam at the head of Dan River, which has undoubtedly been blasted out. It will be rebuilt so strongly as to render this impossible. More intimate knowledge of this river in this reach leads me to confirm all that I have said in regard to its being worthy of improvement and to add a considerable more in the way of emphasizing the same. To economize space, everything that needs to be said in regard to future work has been placed under the general heading "improving Black River, Arkansas and Missouri," as that covers the same ground.

COMMERCE.

See report for "improving Black River, Arkansas and Missouri."

Money statement.

Amount appropriated by act approved September 19, 1890	\$7,000.00
June 30, 1891, amount expended during fiscal year	3,914.21
July 1, 1891, balance unexpended	3,085.79

Expense account.

Pay rolls	\$2,970.95
Subsistence supplies	614.02
General supplies	178.11
Transportation	9.04
Traveling expenses	80.09
Rent	40.00
Skiff	22.00
Total	3,914.21

W 10.

IMPROVEMENT OF ST. FRANCIS RIVER, ARKANSAS.

Earliest appropriation made for this river under any head was made by act approved March 2, 1833.

Summing up all the various works of improvement it may be inferred that prior to 1833 this river was much choked with drift piles, logs, and snags, its waters spread out through a great variety of sloughs, while overhanging trees added to the difficulties of navigation. In the originally-adopted project snagging operations figured largely and attempts have been made to close up some of the many sloughs. This river has been united so often with the White River and also with the Black

River that it is impossible to give exactly how much had been expended upon the St. Francis River to June 30, 1884.

From June 30, 1884, to June 30, 1890, \$24,000 were appropriated; \$12,000 in 1884, \$8,000 in 1886, and \$4,000 in 1888, and this had been practically expended. The history of its expenditure is the history of all work in new countries, with entirely inadequate appropriations, made over long reaches of river. Most constant and careful study has been given to making the money do as much work as possible. The snag boat *Johnson* was first designed for this river, and its light draft, great power, and light running expenses were first utilized on this river. A vast amount of very hard pioneer work has been done. Once or twice sickness in the swamps has demoralized the crew. Diverse interests have opposed the boat's progress here and there, but with steady persistence the work has been carried on, looking to the ultimate opening of the river as contemplated in the original project. The little reach above the Sunk Lands has been well opened and greatly to the advantage of commerce. The transfer of the boat has caused great delay.

This has been obviated by building a separate twin boat partly out of the appropriation to operate above the Sunk Lands in conjunction with the appropriation "improving St. Francis River, Missouri."

By act approved September 19, 1890, \$4,000 only was appropriated to carry forward this work; \$8,000 was recommended. Some criticisms have been passed locally upon the close estimates made, and I have been urged to increase them because they will be scaled. I can not see the policy in doing this and can only report that where estimates are close it will be found eventually that steady progress will be made, though it takes more time for it to appear. During the fiscal year ending June 30, 1891, the water has been too high for effective snagging, which should be done at or near low water. The boat has been moved to the vicinity of its next work and will be put in the field as early in the next fiscal year as the water will permit. A small sum was expended pro rata upon a new snag boat for the reach from Kennett, Mo., to St. Francis, Ark., as explained above. It is scarcely proper to include in this report anything that is a reiteration of the reports of former years, yet in order to obtain the information necessary to a thorough understanding of the merits of the river, its commerce, the amount of water in its channel, the difficulties under which it is worked, it is absolutely necessary that the reports for the last 5 years be carefully gone over. The more study I have given the stream and the country the more interesting the study becomes and the more convincing are the arguments in favor of opening up the river. With no transportation except the wagon, a fertile section rapidly settling up between Lesters Landing and St. Francis would at once pour out through this channel its products, adding many times the sum required for the improvements to the material prosperity of the country. Whatever decision may be rendered as to the desirability of further expenditure, the river now has a plant of its own, peculiarly adapted to its work, and can be cared for at a very small outlay. It would be better to put the river in excellent shape before the plant deteriorates, and it is believed that after a few years of thorough work the river will maintain itself. As to future demands, the development of the country can alone decide what these will be. It may be that dredging the Sunk Lands to bring the river back to its own channel may be warranted in years to come and that low-water navigation may be demanded. At present the prospect is too remote to devote time to plans and estimates for these improvements.

The plan recommended for several years that \$8,000 be appropriated annually not having been carried out the river is fully \$28,000 behind in needed improvements, and that sum could be profitably expended in the fiscal year ending June 30, 1893.

The work is being carried on systematically and effectively, but there is yet much to be done. Nowhere in the State will the results be any more direct, nor is there any section where the amount necessary to improve the stream is any smaller in proportion to the benefit to be conferred.

COMMERCE.

The records do not show what the amount of commerce was before any work was done upon this river. As the river was almost entirely choked with snags, logs, and overhanging trees it must have been very small and, from the best authority I have been able to secure, amounted to a few staves taken out by flatboats propelled by hand. Good authorities, familiar with the river, state that if the river was properly improved freight would be reduced from \$1 per hundred by wagon to 30 to 35 cents per hundred by boat. From what precedes it will be seen that there are no competing routes of transportation. The territory drained by this river is almost entirely dependent upon the river for transportation. As to prospective advantages to commerce if completed they are practically beyond computation. Four letters in my possession, from individuals quite widely separated, all agree upon one point, namely, that the product of the country, and hence its commerce, would be increased 100 per cent. annually were the river improved according to the present plans. Some idea of the general benefits to be conferred upon the community by the completion of the works may be formed from the fact that, with the river only about half prepared for navigation, there was shipped in 1885 and 1886, in the extreme upper part of it, 500 tons of merchandise, 600,000 staves, and 700,000 feet of lumber. Extending the limit a few miles lower and we have as the present yearly commerce—

Lumber	\$3, 150, 000	Pork	\$300, 000
Staves	225, 000	Potatoes	100, 000
Cotton	450, 000	Miscellaneous	300, 000
Corn	300, 000		

From the lower two-thirds of the river, during medium and high water stages, there are shipped weekly 25,000 bales of cotton, 250,000 sacks of cotton seed, and about 175 tons of merchandise.

Comments as to benefits derived are unnecessary.

This is one of the most deserving rivers of the State. Several letters in my possession go to show that the money expended with light-draft boats since 1884 has produced great changes in navigation. Replies to letters sent out to obtain statistics may be condensed as follows, viz:

River improvement would be the means of settling up the country and cause it to produce thousands of dollars' worth of timber and corn. It would reduce the rates of freight fully 25 per cent., as the boats now running could carry double the amount of freight at but little extra expense. It is estimated that four times as much freight would be shipped by the river.

Mr. Robert F. Sanders, of Kennett, Mo., estimates that if the river was properly improved there would be annually produced and shipped, over and above what is now shipped, 25,000 bushels of corn, 100,000 tons of cotton seed, 100,000 white-oak staves, and millions of cypress shingles.

2062 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Tonnage of St. Francis River, Arkansas.

	Tons.
Cotton (40,000 bales)	10, 000
Cotton seed	17, 500
Corn (300,000 bushels).....	6, 600
Perk	5, 000
Potatoes (300,000 bushels)	9, 000
Merchandise	2, 500
Lumber (337,000,000 feet).....	674, 000
Staves (120,000 feet)	6, 000
	<hr/> 730, 600

Money statement.

July 1, 1890, balance unexpended	\$2. 42
Amount appropriated by act approved September 19, 1890.....	4, 000. 00
	<hr/> 4, 002. 42
June 30, 1891, amount expended during fiscal year.....	2, 501. 53
	<hr/> July 1, 1891, balance unexpended
July 1, 1891, outstanding liabilities.....	1, 500. 90
	<hr/> 298. 10
July 1, 1891, balance available.....	1, 302. 80
	<hr/>
{ Amount (estimated) required for completion of existing project.....	28, 000. 00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	28, 000. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Expense account.

Pay rolls.....	\$1, 321. 04
Subsistence supplies	216. 18
General supplies.....	334. 00
Transportation.....	13. 20
Traveling expenses.....	161. 35
Stationery	15. 75
Rent.....	40. 00
Machinery	400. 00
	<hr/> 2, 501. 53

W II.

IMPROVEMENT OF ST. FRANCIS RIVER, MISSOURI

The first appropriation made for this work was that of \$5,000 by act of August 11, 1888. Prior to this time the river channel was choked with logs and snags, overhanging trees interfered with the smokestacks, and several shoals interfered with low-water navigation. The original project contemplated the removal of the shoals 12 miles below Greenville, Mo., the removal by a snag boat of stumps, snags, and overhanging trees from Greenville, Mo., to the town of St. Francis, Ark. Up to June 30, 1890, \$5,000 had been expended opening up very thoroughly the river from Greenville, Mo., to a point about 80 miles above St. Francis, Ark. A few obstructions were removed over this latter reach.

By act approved September 19, 1890, \$10,500 were appropriated to carry on the work. As much trouble had been experienced in getting

the snag boat *A. B. Johnson* through the Sunk Lands, this being a barrier impassable except at extreme high water, and being a natural division of the river into its districts, rather than the arbitrary one at St. Francis, Ark., proper authority was secured to build a snag boat, the duplicate of the *Johnson*, to operate above the Sunk Lands altogether, leaving the *Johnson* for the work below and also for the work in Little River. During the fiscal year ending June 30, 1891, this boat was built and equipped. From the time the boat was completed to the close of the fiscal year the water was too high for effective operations, and the boat was laid up in ordinary accordingly. As early in the next fiscal year as the water will permit the boat will be put into the field and operated, first over the 80 miles not worked under the former appropriation, and then attention will be given to the shoals 12 miles below Greenville. The balance in hand can not be pronounced upon as to its sufficiency, inasmuch as the act provides for the payment of a claim supposed to be presented by the Dunklin County Transportation Company for a cut-off owned by them. No such claim has yet been presented, and it is doubtful if it ever will be, as the territory was a swamp and it was at their most urgent request that it was improved, as may be shown by the records, and was of no account to low-water navigation until it was opened by the snag boat. If this claim is not presented, then no money will be required to complete the present project; if it is, then the amount of the claim in addition will be required.

This reach of river will some day require very careful attention, as it drains a very rich and fertile territory, now little known.

COMMERCE.

For commerce, see "Improving St. Francis River, Arkansas."

Money statement.

Amount appropriated by act approved September 19, 1890	\$10,500.00
June 30, 1891, amount expended during fiscal year	2,642.68
July 1, 1891, balance unexpended.....	7,857.32
July 1, 1891, outstanding liabilities.....	120.00
July 1, 1891, balance available	7,737.32

Expense account.

Pay rolls	\$1,370.70
General supplies	1,074.38
Transportation	23.98
Traveling expenses	66.90
Stationery	9.00
Lumber.....	61.35
Skiff.....	22.00
Reserved in United States Treasury for freight charges	14.37
Total	2,642.68

W 12.

IMPROVEMENT OF LITTLE RIVER, MISSOURI AND ARKANSAS.

The first appropriation ever made for this river was that of the act which became a law August 11, 1888, amounting to \$5,000 (five-eighths of the estimate, \$8,000). The project for improvement contemplates rendering it navigable at high and medium stages from Hornersville to its junction with the St. Francis River, especially to prolong the medium stage of water by confining the water to one of the two chutes making out of the lake upon which Hornersville is situated, and by removing the snags, logs, and masses of driftwood that have accumulated in the channel. The project for the expenditure of the \$5,000 referred to above, provides that it be expended as follows, viz: \$1,500, or as much as may be necessary, in building a dam across one of the chutes at or near the lake, and the balance in removing the worst obstructions in the way of overhanging trees, logs, snags, and drift, over the distance specified, and that the snag boat *A. B. Johnson* be used for this work, being transferred in due form and by proper authority and at the proper time for this purpose, the dam to be constructed of brush and gravel, brush and rocks, or of such other material as may be had in the locality as may be best adapted to the purpose.

The work to be executed by hired labor and the purchase of material in open market, as this is most economical and advantageous to the Government. It will be seen that this provides for the use of the snag boat *A. B. Johnson*.

Owing to the boat being required elsewhere and to an accident to the same in the fall of 1889, and to high water, no work was done until early in the fiscal year ending June 30, 1891. Operations were vigorously carried on from July 5, 1890, until August 23, when water became too low to move the operating boat. Work was all done at or near extreme low water and extended over 80 miles of the river, i. e., from its mouth to Perkins Bar. This carried the work to within about 20 miles of the foot of the lake. In addition to this work, a dam 300 feet long and from $1\frac{1}{2}$ to $5\frac{1}{2}$ feet high was built across the right chute. Over the 80-mile reach, 161 trees were cut, 109 snags removed, and 25 cubic yards of earth excavated.

By act approved September 19, 1890, \$3,000 was appropriated. On November 22, 1890, the water continuing low and the boat being required for work upon the appropriation to which she properly belongs, she was withdrawn from the river.

The next suitable time for work will be in the early part of the next fiscal year, and steps will be taken to put the boat in the field at the proper time. Great relief has been afforded already, and it is believed that the present funds will do all the work required at present. I am informed that extensive preparations are being made to utilize the channel as soon as opened.

COMMERCE.

Hornersville ships yearly about 20,000 bales of cotton, 500,000 bushels of grain, and a good quantity of stock. This is the only outlet this section has, except wagons. Like many other streams in this State, it has upon its banks some very fine timber, which only waits a free water way to find a ready market. Hornersville is backed by a large tract of improved country, whose main distributing point it is. The water way itself is partly a lake and partly two narrow rivers. The

lake extends about 12 miles from Hornersville. This lake is drained into St. Francis River by two chutes that are known together as Little River. It is too soon to give effects upon rates of insurance and freight. It has no competing routes of transportation. As to prospective advantages to commerce and benefits to community if completed, there will be the same results in a general way as enumerated for St. Francis River, as it is one of its feeders.

Money statement.

July 1, 1890, balance unexpended	\$2, 897. 59
Amount appropriated by act approved September 19, 1890	3, 000. 00
	5, 897. 59
June 30, 1891, amount expended during fiscal year	2, 865. 69
July 1, 1891, balance unexpended	3, 031. 90

Expense account.

Pay rolls	\$2, 356. 00
Subsistence supplies	183. 20
General supplies	199. 34
Transportation	15. 65
Traveling expenses	21. 95
Stationery	23. 20
Rent	44. 00
Reserved in United States Treasury for freight charges	22. 35
	2, 865. 69

Tonnage, 2,611 tons.

W 13.

**PRELIMINARY EXAMINATION OF CURRENT RIVER, FROM VAN BUREN,
MISSOURI, TO ITS MOUTH.**

[Printed in House Ex. Doc. No. 157, Fifty-first Congress, second session.]

**UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., December 11, 1890.**

GENERAL: In accordance with the requirements of letters dated Office of the Chief of Engineers, Washington, D. C., September 20, 1890, I have the honor to submit the following report* upon the preliminary examinations of Current River, Missouri and Arkansas:

It being found impossible, consistent with the interests of the works under my charge, to make this examination in person, a competent civil engineer of experience was engaged to make this examination, and from his very full report now before me, appended, I am able to make the following statements, viz:

No further examinations will be necessary to enable me to submit plans and estimates for the improvement of the navigable reach of this river. It is worthy of the improvement, and the outlay necessary for the same is fully warranted by the interests involved.

It appears that there are 95 miles of this river from the mouth to Van Buren that are navigable throughout the whole year, as there is an abundance of water. The discharge at Van Buren at a low-water stage

* Map not reprinted.

is 2,200 cubic feet per second. About 4 miles below this point is a large spring, which affords about 700 cubic feet more. The average width at low-water stage is 200 feet and the velocity 2.75 miles per hour. The flood oscillation is about 16 feet. The Current River at time of floods is very swift, and has a tendency to clear the channel of obstructions in the way of snags, though many large clay-filled roots, too obstinate to be moved in this way, are lodged in the channel and make serious obstructions to navigation. Other obstructions in the way of shoals may be readily improved by a system of wing dams, built of rock and willow brush, for the purpose of contracting the channel.

This style of wing dam has been successfully operated on Upper White River. The commerce demanding the improvement of this river is approximately estimated to be 112,500 tons of lumber per annum in Carter County, Mo., besides twenty-one sections of undeveloped mineral lands (iron and lead), of which I have specimens now in my office that will compare favorably with the ores of Iron Mountain and De Loze lead mines, Missouri.

In Ripley County 23,064 tons of lumber, 1,112 bales of cotton, and 120 carloads of flour and grain, besides merchandise, received.

From the State line to the mouth in Arkansas, 35,000 tons of timber, 3,500 bales of cotton, besides grain and merchandise.

With the foregoing in view, it is recommended that \$10,000 be appropriated for improving this river from Van Buren to its mouth, to be applied as follows, viz:

For building and equipping one small hand-propelled snag boat	\$4, 000
For running expenses of this boat 4 months	3, 750
For building of wing dams	710
For one rock barge	350
For contingent expenses	1, 190
Total	10, 000

Before closing this report it is my duty to invite attention to the fact that a railroad bridge spans the river 3 miles below Van Buren, unprovided with a draw span, and so low as to present an impassable obstacle to navigation. This bridge belongs to the Current River Railroad Company. This structure will be made a subject for report, as required by law. It will have to be attended to before the improvement is successfully carried out. It is presumed there will be no difficulty in this matter, as the policy of the railroads in this State seems to have been to erect a bridge and operate it just as long as they should be undisturbed, and comply with the law when navigation demanded the passage of boats.

The people of Van Buren consider it an imposition on the part of the railroad company in putting this bridge across the river, shutting out navigation to their town.

A reference to the Annual Report Chief of Engineers, 1881, Part II, pages 1467 to 1469, will show that the sum recommended is about the sum recommended by Major Benyaurd. The difference is due to the new model snag boat recently constructed for these rivers, which can do as effective work as the more expensive boats, and yet does not cost so much to run monthly by some \$1,600 or \$1,700.

I am, sir, very respectfully, your obedient servant,

H. S. TABER,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, December 18, 1890.

Respectfully forwarded to the Chief of Engineers.

I am of opinion that the Current River is worthy of improvement for the reasons and to the extent stated by the district officer.

C. B. COMSTOCK,
Col. of Engrs., Bvt. Brig. Gen., U. S. A.,
Division Engineer.

REPORTS OF MR. J. R. VAN FRANK, ASSISTANT ENGINEER.

1.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., November 3, 1890.

CAPTAIN: I have the honor to submit herewith my report of the examination of Current River from Van Buren, Mo., to the mouth, where it empties into Black River.

According to your instructions I proceeded to Van Buren on the 21st of October, 1890, via St. Louis, Iron Mountain and Southern Railway, to Williamsville, Mo.; thence, via Cape Girardeau and Southwestern Railway, to Grandin, Mo.; thence, via Current River Railway, to Chicopee, the station on the opposite side of the river from Van Buren.

Van Buren is the county seat of Carter County, Mo., a town of about 200 inhabitants, four general merchandise stores, one drug store, hotel, livery stable, blacksmith shop, saw and grist mill, court-house, schoolhouse, and churches.

Mr. Alex. Carter, the oldest and one of the prominent merchants, informed me that Current River has always been considered navigable to that point, and even above there to the mouth of Jacks Fork, 30 miles above. Until late years flatboating was carried on between there and Pocahontas, a point on Black River, accessible to steamboats adapted to the lower river. The principal commerce of the river at the present date is rafting of logs, lumber, and square timbers; a large quantity of cedar poles has been rafted from Jacks Fork this season. I found no one that could give me an estimate of the amount.

Pine is the principal timber rafted from the vicinity of Van Buren and below. The hills of Carter County, adjacent to the river, are heavily timbered with pine. It is estimated by some of the prominent citizens of Van Buren that there is 800,000,000 feet of timber adjacent to the river north of there undisturbed by mill and raftsmen.

This interest is being developed along the lines of the Current River Railway and the Cape Girardeau and Southwestern Railway. At Grandin, the present terminus of the Current River Railway, there are two sawmills with a combined capacity of 150,000 feet per day. This milling company, called the Missouri Iron and Lumber Company, has contracted with the railroad company to furnish them with 10 cars per day.

A new mill is being built 3 miles below Van Buren, with a capacity of 20,000 feet per day. Keen's mill, $6\frac{1}{2}$ miles below, combined capacity of 40,000 feet per day; Carter & Clay's, at Chilton, $8\frac{1}{2}$ miles below, combined capacity of 40,000 feet per day. Other mills at copper mine and west of the river, of which I did not get an estimate, together with the above mentioned, all have an interest in the logging and rafting commerce of the reach of Current River above and for 20 miles below Van Buren. Aside from the lumber there is a large tract of undeveloped mineral lands immediately on and adjacent to the river in Carter County. It is estimated at fifteen sections of iron ore, six sections of lead, besides copper and manganese. There is also a good quality of marble in this vicinity.

The agricultural lands are largely undeveloped, and as yet give little commerce to the river in this vicinity. So far I have outlined the commerce above and for 20 miles below Van Buren to the vicinity of Ripley County line. The commerce of this county is as large in the lumber interest as that of Carter County. The agricultural lands are more fertile and well developed.

Doniphan, the county seat, has about 800 inhabitants, is a prosperous and growing town, and has communication with the outside world by means of a branch of the St. Louis, Iron Mountain and Southern Railway from Neelyville, a distance of 20 miles. This railroad was built in 1883. Previous to this date steamboats navigated Current

River to this point and loaded with cotton and corn, also bring merchandise up the river from Memphis.

Two of the enterprising business firms of Doniphan—Borth, Barret & Co., and Neil & Co.—estimated the commerce partially to be as follows:

Shipments: Cotton, 1,112 bales per year; lumber, 8,000,000 feet per year; receipts of flour, 60 carloads per year.

Statistics in regard to merchandise and other articles of commerce, upon which I did not get an estimate, may be obtained from Mr. A. Skinner, railway agent at Doniphan.

Five million nine hundred and thirty-two thousand feet of logs were rafted down to this point during the year. I estimate that there are 1,000,000 feet of logs in rafts and on the bank between Doniphan and Carter County, 21 miles above.

Buffalo Creek empties into Current River 12 miles above Doniphan. Along this creek there are 5,000 acres of land under cultivation. From this point down there are numerous farms; in fact, line the banks of the river to the State line. Thus far I have covered 53 miles of river from Van Buren. Pitman's Ferry, at the State line between Missouri and Arkansas, is at present the head of steamboat navigation. There is a tie and stave interest from this point down, giving traffic for steamboats. There are few farms immediately on the river for the next 10 miles, though on either side there is a broad strip of bottom land heavily timbered and with a thick undergrowth, indicating a strong fertile soil. No reason can be assigned for this noncultivation, except that the settlement has not spread out thus far. Back from the river a few miles, and just above the mouth of Little Black River, a tributary to Current River, is a large farm of several thousand acres; this produces 75 bushels of corn or a bale of cotton per acre. Below the mouth of Little Black is a strip of cultivated land known as the Cherokee Bay country. Last year this section produced 3,500 bales of cotton; this year the crop is larger. Seven miles below the mouth of Little Black and 25 miles above the mouth of Current River is a trading point for the bay country known as "Jim Johnson;" at this place is a store, sawmill, feed mill, cotton gin, and ferry. At the present low stage of water steamboats are making regular trips each week to this point. On the opposite side of the river and a mile above is another sawmill, giving some business to the steamboats in the way of oak, lumber, and cross-ties. There are numerous logging camps dotting the line of river from the State line to the mouth. During my observations I estimate timber in sight delivered on the bank ready for transportation at 6,000 cross-ties, 150,000 staves, and 1,000,000 feet of oak and cypress logs. It is estimated there are 4,000,000 feet of logs in Little Black. Pocahontas is situated about 4 miles below the mouth of Current River.

The firm of Imboden Bros., dealers in general merchandise at this place, gave me the following data in the way of commerce: Six thousand five hundred bales of cotton shipped during the year; the steamer *Bragg* has made a rate of \$1.75 per bale on cotton via Newport to St. Louis. Two other steamboats, the *Hope* and (?) ply this trade. Twelve million feet of logs and 300,000 ties passed Pocahontas during the past year. No estimate on staves was given, but I was referred to Morrison & Decker, of Newport, Ark.

Mr. James M. Lane, of the firm of Purdee, Cook & Co., of Chicago, Ill., has purchased 17,000 acres of timber on Current River and Little Black River, and has established a mill at Black Rock, Ark. His plan is to put a small towboat on the river and take out 10,000,000 feet of logs per annum.

I have prepared a table of distances, closely estimated by observation and compared with the original Government land statements. This estimate varies considerably from the distances given me by parties along the river. For instance, the distance from McElroy's Ferry to the mouth is called 30 miles. It took me $3\frac{1}{4}$ hours to run this reach in a batteau with a current of three-fourths mile per hour. I estimate the distance to be $9\frac{1}{2}$ miles instead of 30 miles.

	Distance from Van Buren		Distance from Van Buren.
	Miles.		Miles.
Discharge section, 2,200 cubic feet per second	0	Big Spring, affords 700 cubic feet per second	4.25
Ferry .....	.25	Rock boulders thrown into river from railroad cut	5.50
Shoal	1	Keen Ferry and sawmill	6.75
Rapid Chute, 3 feet deep, with three snags	1.50	Head of island	7
Head of isle, right chute 100 feet wide, 4 to 6 feet deep	2.25	Rock reef (200 feet done)	8.25
End of isle (new mill)	2.75	Colmans Failure and Chilton	8.75
Shoal 1.5 feet deep (100 feet done)	3	Mouth of Copper Mine Creek	10
Railroad bridge	3.25	Shoal, head of island	10.25
Shoal, 1.3 feet deep, diagonal, bad (200 feet done)	3.50	Cataract and snags	11.25
		Bend	11.50

	Distance from Van Buren.		Distance from Van Buren.
	<i>Miles.</i>		<i>Miles.</i>
End of island	12	Shoal, 2.3 feet deep	42.25
Ford and shoal, 2 feet deep	12.25	Shoal, 1.5 feet deep, head of chute on right	42.75
Shoal, 2 feet deep	12.50	Bend to left, water 1.2 feet deep	43.25
Mouth of creek Smooth River to Bart Camp Creek	13.50	Shoal, 2 feet deep	43.50
Mouth of Bart Camp Creek	15	Bend to right	44
Rock Dam, shoal 2 feet deep	15.25	Shoal 2 feet deep	44.50
Bend, Cedar Bluff	16.75	Shoal at mouth of Mulberry Creek	45
Shoal, 1.5 feet deep, can be improved by wing dams from right bank	17	Snags in bend and mouth of Caughom Creek	45.75
Islands and crooked channel, caving banks on left	18	Chute to left, head of island	46.25
Shoal just above bay at Phillips Mill	18.75	Snags	46.50
Snags in bend	19	Mouth of Mill Creek and Shoal	46.75
Shoal, needs contracting, raft lodged	19.25	Bend to left and bad snags	47.50
Bad snags in swift current, banks caving on left	19.50	Mouth of Dudley Creek and Pata Bay	47.75
Narrow chute 100 feet wide, 5 feet deep, swift	19.75	Three chutes; the right chute is deep and narrow, though it should be closed, turning the water through center chute, thus making the channel straight; bad snags at the lower end of these chutes	48
Shoal (upper) at head of towhead, 2 feet deep, rapid current	20	Bad snags	48.25
Shoal below, 2 feet deep; this ends the bad reach of 1 mile	20.25	Tow-heads, crooked channel, and bad snags. Improvements can be made by building dam from left shore and taking out snags, so as to utilize the left chute	48.50
South line of Carter County	21	Indian Ferry	49.25
Shoal 2 feet deep	22.25	Shoal 2 feet deep, rapid below, chute on right	50
Bend	23	Rock points to left	50.50
Jakes Valley	23.75	Marvel Bend, many bad snags	51
Shoal 1.5 feet deep	24	Head of Cane Chute; is narrow and deep; cut-off rock bluff on the left is one-third of a mile long	52
Mouth of Big Harren Creek	24.50	State line, cut off, very crooked, bad snags	53
Shoal 2 feet deep	25	Pittman Ferry; steamboats run to this point	53.50
Do	25.50	Shoal 2 feet deep, rapid current	54.50
The bend above Club House is filled with snags	25.75	Do	55
Ripley County Club House	26	Bad snags	56
Snags and rapid current	26.25	Cultivation on right bank	57
Shoal	26.50	Shallow water, straight reach	58
Mouth of Little Barren Creek, cultivated fields on right bank	27	Head of island; chute on the right is nar- row and deep, rocky bank on the right; this is the last rock that shows on the bank of the river	58.50
Mouth of Buffalo Creek	29	Lower end of island	59
Shoal, not bad, large spring on right	30	James Price's farmhouse	61
Small chute to left, runs back to bluff and comes in 1 mile below	31	Bad snags	61.50
Bad shoal, 1 foot deep, tow-head and chute on left; gravel bar extends diagonally down the river from right bank	31.50	Cut-off at mouth of Little Black River; snags	62
Mouth of chute and end of island	32	Duff Ferry	63.25
Bay at Jones Mill, end of isle, mouth of chute and Capps Creek	32.50	Richardson Ferry	65
Shoal 2 feet deep, rapid	33.50	Farmhouse; old store stand	65.50
Sharp bend to left, tow-head and rapid current	33.75	Logging on left bank and Cypress Lake	67
Middle of chute running east, rapid cur- rent	34	Sawmill on right bank	68.25
Sharp bend to right, water 12 feet deep	34.25	Jim Johnson Ferry, store, sawmill, and cotton gin	69.50
Mouth of Wells Creek, raft yard, bluff, bend to left	34.50	Cut-off at Shumakar Ferry	71
A good reach of river called Birds Reach, course southeast for 2 miles	37	Caseys cotton gin	73.75
Mouth of Isaacs Creek	38	Gayhardt Ferry	78
McGee Ford and mouth of Simpson Creek	38.75	Bend; large two-story frame house	79
Mouth of Bills Creek	39.75	McIlroy Ferry	85.25
Worley Rock	40.75	Cut-off, should be cleared of snags	85.50
Head of island and ford; chute on left runs to Neils Mill	41.50	Farmhouse on right bank	87.25
Ferry at Domiphan	41.75	Logging camp	89.75
Shoal, 1.5 feet deep, mill dam; water is deeper next right bank		Mouth of Current River	94.50
		Black River: Jeff Carter's place	94.75
		Mouth of Fourche Dumas	98.50
		Pocahontas	99.50

The character of the river from Van Buren down 33 miles is a swift, even current; velocity about 2.75 miles per hour at the present low-water stage; the width is about 200 feet and depth from 2 to 6 feet; the oscillation 16 feet.

The discharge at Van Buren is 2,200 cubic feet per second; stage of water, 0.5 feet; the width of overflow from 600 to 800 feet; average height of bank above low water 12 feet; average width between banks, 400 feet; average fall per mile, 2.5 feet.

There are very few snags in this reach of river; the rapid current has a tendency to clear everything in its course, even to making level the bed of the stream, as the even depth of water shows no pools, no rock reefs, but an even gravel bed. The banks are substantial; few overhanging trees obstruct navigation in the bends and chutes. There are few shoals that have less than 2 feet of water in low-water season.

The Current Railway Bridge, three-fourths mile below Van Buren, is a combined wood and iron truss, 450 feet long; there are 3 fixed spans 150 feet each; the piers consist of 2 iron cylindrical caissons 6 feet in diameter, filled with concrete; the cross-beams and lower chords are 325 feet above low water. This is the only permanent obstruction to navigation on the whole river. The first bad reach is 19 miles below Van Buren and extends $1\frac{1}{2}$ miles, has a crooked channel, rapid current, bad snags, and two shoal places; a channel of 2 feet of water over the shoals can not be utilized on account of snags. Another bad place was encountered at $25\frac{1}{2}$ miles distance, where 10 or 12 snags occupied the channel, leaving the only room for a raft or boat next the gravel bar, 1 foot deep; there would be 6 feet of water in the channel were the snags taken away. The only bad shoal on the whole river where there does not seem to be enough water to float a 20-inch sawlog is $31\frac{1}{2}$ miles down the river; there are two chutes here to divide the water, which, if closed by rock and willow dams, with an additional wing-dam on the opposite side to contract the channel, would give plenty of water over the shoals.

At a point $1\frac{1}{2}$ miles above Doniphan is a large rock, known as Worley Rock, about 10 or 12 feet in diameter; the water is deep to one side of this rock, but the current carries a raft directly over it, making it a dangerous obstacle to encounter. This may be blasted out.

Doniphan is $4\frac{1}{2}$ miles from Van Buren; from this place to the State line is where the most of the snagging should be done and overhanging trees cut. In some of the bends where the banks are caving the trees should be cut to prevent their falling into the river and lodging. There are no bad shoals but that have plenty of water to be overcome by a boat drawing from 18 to 24 inches of water.

At a point 48 miles down the river are three chutes. The water divides to such an extent that the middle chute is shallow at the upper end, leaving the side and crooked chute to be navigated; these side chutes should be closed by rock and willow dams, throwing the water at a low stage through the middle chute. Another point one-half mile below this is similar and can be improved by removing snags from the straight channel.

Still farther down the river is Cane Chute. This is a cut-off, straight, narrow, and deep; overhanging trees obstruct navigation. One mile farther down the river is the State Line Cut-off; this has recently been made; is very crooked; the raw edges of the bank are still projecting and many snags are lodged in the channel. From this point down to the mouth the current is more sluggish and the river more winding, giving greater length of river. Two miles below the State line is the last shoal of 2 feet. From there down the depth ranges from 6 to 12 feet. Very little work with a snagboat would put this reach of river in good shape, so that the boats now plying the lower river could run as far up as Pittman Ferry at the State line and carry out the freight now waiting on the bank.

The steamer *Hope* made an attempt to reach this point 10 days ago, but met with difficulty on account of snags and overhanging trees near James Price's farm, and returned down the river.

The cut-off at the mouth of Little Black has several bad snags to be removed. This will bring us into clear river already navigated without difficulty.

Another cut-off just below McIlroy Ferry, not used at present on account of being choked with snags, could be cleared and thereby shorten the distance 2 miles.

No other obstructions were encountered on to the mouth, though outside of my brief outline of work to be effected many contingencies will occur to give employment to a snagging outfit during the season.

Very respectfully submitted.

Your obedient servant,

J. R. VAN FRANK,
Assistant Engineer.

Capt. H. S. TABER,
Corps of Engineers, U. S. A.

2.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., December 1, 1890.

CAPTAIN: I have the honor to submit as an appendix to my report herewith an estimate of cost of removing obstructions in Current River from Van Buren, Mo., to the mouth, viz:

One hand snagboat fitted with steam hoisting power	\$4,000
Expense of running same 4 months	2,800
	<hr/> 6,800

Cost of wing dams:

3 miles, 100 linear feet, at 30 cents	\$30
3.5 miles, 200 linear feet, at 30 cents	60
8.25 miles, 200 linear feet, at 30 cents	60
17 miles, 100 linear feet, at 30 cents	30
19.25 miles, 200 linear feet, at 30 cents	60
20 miles, 100 linear feet, at 30 cents	30
23.75 miles, 100 linear feet, at 30 cents	30
31 miles, { 100 linear feet, at 30 cents	30
{ 50 linear feet, at 30 cents	15
31.50 miles, 200 linear feet, at 30 cents	60
42.75 miles, 50 linear feet, at 30 cents	15
48 miles, { 150 linear feet, at 30 cents	45
{ 150 linear feet, at 30 cents	45
48.50 miles, 200 linear feet, at 30 cents	60
53 miles, 200 linear feet, at 30 cents	60
54.50 miles, 100 linear feet, at 30 cents	30
Total, 2,200 linear feet, at 30 cents	<hr/> 680
Worley Rock (blasted)	50
Superintendent, 4 months, at \$125 per month	500
Custodian and recorder, 6 months, at \$75 per month	450
One rock barge	350
Total	<hr/> 8,810

Very respectfully, your obedient servant,

J. R. VAN FRANK,
Assistant Engineer.

Capt. H. S. TABER,
Corps of Engineers, U. S. A.

APPENDIX X.

PRELIMINARY EXAMINATION OF MISSISSIPPI RIVER FROM HIGH-WATER MARK, LAKE COUNTY, TENNESSEE, TO HIGH-WATER MARK, FULTON COUNTY, KENTUCKY, NORTH AND WEST OF REEF FOOT [REELFOOT] LAKE TO ASCERTAIN IF NAVIGATION OF THE RIVER MAY NOT BE IMPROVED BY RESTRAINING THE FLOW OF WATER INTO SAID LAKE, AND ADJOINING LOW LANDS.

REPORT OF CAPTAIN S. W. ROESSLER, CORPS OF ENGINEERS, OFFICER IN CHARGE.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., May 14, 1891.

GENERAL: In compliance with the Department letter of the 20th of September, 1890, I have the honor to submit the following report of a preliminary examination of the "Mississippi River from high-water mark, Lake County, Tennessee, to high-water mark, Fulton County, Kentucky, north and west of Reelfoot Lake, to ascertain if navigation of the river may not be improved by restraining the flow of water into said lake, and adjoining low lands." The examination in the field was made by Assistant Engineer William M. Rees, a copy of whose report is hereto appended.

The escape of water into the basin of Reelfoot Lake is limited on the east by the high bluff at Hickman and on the west by Prairie Ridge, a high piece of ground from 5 to 7 feet above the highest known water. The piece of river included between these two high grounds is about 23 miles long, and has banks varying in height from 4 to 11 feet below the high water of 1883, the highest here known, the mean depth of overflow being about 7 feet. The water diverted from the main river over this bank flows in a direction generally parallel to the main river through the basin of Reelfoot Lake, Isom Lake, and Beaver Lake, joins the valley of the Obion, a short distance above its mouth, and returns to the main stream at Hale's Point, 100 miles below Hickman. The overflowed area due to this escape of water is estimated at about 280,000 acres, including Reelfoot Lake. From indirect data it has been estimated that the overflow during the high water of 1883 reached a maximum of nearly 200,000 cubic feet per second.

The divergence of so large an amount of water could not fail to exert a deleterious influence on the bed of the river in New Madrid Reach, and the construction of a levee to restrain it would, in my opinion, prove beneficial to the navigation of the river and at the same time protect a large area of tillable land from overflow.

The approximate location of a levee connecting the bluffs at Hickman with the high ground above Tiptonville and following the bank of the

river is indicated on the accompanying map. The location as given is that of a preliminary survey of the Mississippi, Tennessee and Georgia Railroad Company, made several years ago with the view at the time (but since abandoned) of building a riverside railroad from Hickman south towards Dyersburg. Using the profiles of this survey as basis for an estimate, a levee suitable for restraining the highest overflow known would be about 20 miles long, with an average height of 10.2 feet, and, allowing for a crown width of 6 feet and side slopes of $2\frac{1}{2}$ to 1 and 3 to 1, would contain approximately 1,300,000 cubic yards, which at 20 cents per yard would cost \$260,000.

I have been led to understand that the overflowed district aided by the city of Hickman would be in a position to contribute about \$125,000 of the above amount if the United States would supply the remainder. At the time the railroad project was under consideration the following amounts were guaranteed the railroad as an inducement to build the levee and occupy it as a roadbed:

Subscription city of Hickman, Ky.....	\$25, 000
Tax on 25,000 acres in Kentucky, \$2.....	50, 000
Subscription of 25,000 acres in Tennessee, \$2.....	50, 000
Total.....	125, 000

And the same amounts are again presented as the probable resources of the district in aid of the construction of a simple levee. The balance, \$135,000, to complete the levee would be an advantageous investment to the Government, as there is probably no portion of the river where so small an expenditure would restrain so large a volume in the channel in time of flood and maintain it there for such a long distance; for the gap between Hickman and Prairie Ridge closed, there will be no considerable overflow within a distance of 50 miles below Hickman. The principle adopted by the Commission of using levees as important adjuncts to the improvement of the low-water navigation would find special application in this case.

The estimate of cost above submitted, though subject to corrections by exact surveys, is believed not to be seriously in error.

The locality is worthy of improvement in the manner stated.

Very respectfully, your obedient servant,

S. W. ROESSLER,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[Third indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, May 28, 1891.

Respectfully forwarded to the Chief of Engineers.

The river and harbor act of September 19, 1890, provides for an examination "north and west of Reelfoot Lake to ascertain if navigation of the river may not be improved by restraining the flow of water into said lake and adjoining low lands."

The estimated cost of the restraint is \$260,000. In my opinion the amount of improvement of the Mississippi River by this expenditure would be too small to justify the expenditure and therefore I do not think the river worthy of improvement by this method.



This enterprise has been presented to the Mississippi River Commission more than once by the Mississippi Levee Company, and aid from the Commission has been asked, but the Commission has not as yet recommended any allotment for the purpose.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

REPORT OF MR. W. M. REES, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., May 11, 1891.

CAPTAIN: In compliance with your instructions of May 1, I have the honor to report upon "a preliminary examination of the location of a proposed levee, from the high ground at Hickman, Ky., to the high ground above Tiptonville, Tenn."

I left Memphis on May 3 and arrived at Hickman, Ky., the following day; here I devoted 2 days collecting data and arranging for a trip over the proposed levee. This I made on the 6th, traveling for the greater part of the distance over the line surveyed by the Mississippi, Tennessee and Georgia Railroad Company, which occupies the high ground in the vicinity of the river, but at a safe distance therefrom.

From an examination of county and other maps, and the maps and profiles of preliminary lines run by the railroad engineers, I find the length of the levee will be about 20 miles, 15 of which are in Kentucky and 5 in Tennessee; and that the average depth of overflow is about 7 feet.

One terminus is the bluffs at Hickman, and the other a high ridge, extending from below Tiptonville to opposite New Madrid, Mo., having an elevation of from 5 to 10 feet above extreme high water.

THE TERRITORY TO BE BENEFITED.

This levee will protect lands in Fulton County, Ky., and in Lake, Obion, and Dyer counties, Tenn.; a strip of land extending from Hickman, Ky., on the north to Hale's Point, at the mouth of Forked Deer River, on the south, a length of 45 miles; and from the Mississippi River on the west to the hills on the east, an average width of 10 miles. In this is situated Reelfoot Lake, a shallow body of water covering about 30,000 acres and having a depth of 5 to 8 feet.

Reliable parties in Hickman, Ky., who have given the problem some study, estimate the lands to be protected at 30,000 acres in Kentucky and 200,000 acres in Tennessee. I have compiled from various sources the following:

Approximate estimate of overflowed lands.

	Acres.
Fulton County, Ky.....	30,000
Lake County, Tenn.....	75,000
Obion County, Tenn.....	*50,000
Dyer County, Tenn.....	†125,000
Total.....	280,000

In Fulton County, Ky., 5,000 acres will probably be left outside the levee. In Obion County, Tenn., Reelfoot Lake covers about 30,000 acres, though it is held that much of this will be reclaimed when the levee is built, the depths being extremely shallow along the margins.

Lake and Dyer counties have lands near the river, which would still be overflowed, and in the latter county the back waters from the Mississippi River will still inundate much of the low lands, though probably not to the present extent. Based upon approximate information only, I estimate the area to be benefited as follows:

	Acres.
Fulton County, Ky.....	25,000
Lake County, Tenn.....	50,000 to 60,000
Obion County, Tenn.....	25,000 to 40,000
Dyer County, Tenn.....	50,000 to 75,000
Total.....	150,000 to 200,000

* Including Reelfoot Lake.

† North of Forked Deer River.

AREAS UNDER CULTIVATION.

Of the above the following is an approximate estimate of lands now being cultivated and the value, the information being obtained from local authorities.

Fulton County, Ky., 5,000 acres, at \$20	\$100,000
Lake County, Tenn., 10,000 acres, at \$25	250,000

No reliable information as to Obion and Dyer counties could be had. The lands along Reelfoot Lake and its outlet, called the scatters, are low lands and sparsely settled. It is hence safe to estimate that they will not exceed, and probably not reach, the quantities and values of lands above estimated. Probably \$600,000 would be a most liberal estimate of the total value of the cultivated lands in the entire region under consideration.

The wild lands are valued at from \$2 to \$5 per acre, the latter being for well-timbered lands. Taking the average at \$3 per acre and the quantity at 150,000, the total value is \$450,000, which, added to the value of improved lands, is a total of \$1,050,000 for all lands to be benefited.

DEPTH OF OVERFLOW.

The surveys made by the railroad engineers show an average of 7.2 feet depth of overflow, the minimum being about 4 and the maximum about 11 feet, referred to the high water of 1883, the highest here known.

From the personal inspection I made I think it probable that better ground can be found for a levee than on the line surveyed by the railroad engineers.

There are no deep sloughs or crossings to make, and in only a few places will the overflow exceed 10 feet, and then only for a short distance in each case.

QUANTITY OF OVERFLOW.

There is, no doubt, a large escape over the banks during extreme high water, due to the nearness of the river to Reelfoot Lake, the head of which is 6 or 7 miles from the Hickman end, and not exceeding $2\frac{1}{2}$ miles from the lower end. As no observations of discharge have been taken over this bank, I have estimated it by taking the difference between the maximum discharge at Columbus, Ky., above, and at New Madrid, Mo., below, deducting therefrom the escape into St. Francis Basin.

	Cubic feet per second.
The discharge at Columbus, Ky., high water of 1882, was	1,660,496
The net escape into St. Francis Basin between Columbus and New Madrid in 1882 was	2,125
Difference	1,658,371

No high-water discharge observations were made at New Madrid in 1882. I have therefore used those of March 25 and April 10, 1890, and adding the increment to bring the section up to the high-water stage of 1882 to have been 1,459,260 cubic feet. Deducting this from the difference above, gives about 200,000 cubic feet per second as the approximate amount which escapes over the proposed levee location.

This is probably not seriously in error.

ESTIMATE OF COST.

The profile made by the Mississippi, Tennessee and Georgia Railroad Company shows a total embankment of 1,620,000 cubic yards, for a levee of 14 feet crown, slopes 2 to 1 and 3 to 1, and a grade 3 feet above highest known water.

Reducing the crown to 6 feet and making slopes $2\frac{1}{2}$ to 1 and 3 to 1, with the same elevation of grade line, will make the yardage 1,300,000, which, at 20 cents per cubic yard, will make the cost \$260,000. The estimated clearing is about 235 acres, and the price above is intended to include this cost.

PROBABLE REVENUE FROM THE DISTRICT.

In 1872 the State of Kentucky incorporated the Mississippi River Levee Company, a body politic, to construct and maintain a levee from Hickman, Ky., south. The capital stock was not to exceed \$1,000,000, and, with the consent of the majority of the voters in the district, they were to have power to tax all lands protected \$2 per acre and not more than 20 per cent. of valuations for construction purposes. Not exceeding one-

fourth of this tax was to be levied any one year. To maintain the levee they are empowered to lay a tax not exceeding 10 cents per year per acre and 1 per cent. on valuation of town lots.

It being feared that this act had lapsed by non-usage an amendment reviewing it was passed by the Kentucky legislature in 1890. I am informed that the people of the district are almost unanimous in favor of the taxation.

As no such law can be passed by the Tennessee legislature the revenue there must be raised by subscription, all of which I believe have been in lands.

The city of Hickman has voted \$25,000 towards the levee; this act expires June 1, 1892, but it is claimed will be renewed.

The available resources of the district are represented to be as follows:

Tax on 25,000 acres in Kentucky, at \$2	\$50, 000
Subscription of 25,000 acres in Tennessee, at \$2	50, 000
Subscription of Hickman, Ky	25, 000
Total	125, 000

The above was offered as a bonus to the Mississippi, Tennessee and Georgia Railroad if they would build the levee and occupy it as a railroad bed. It is now stated that the railroad company has abandoned the project through their inability to raise funds.

EFFECT UPON IMPROVING THE RIVER.

There is probably no portion of the river where so small an expenditure will confine as large a volume of water in the channel in time of flood and maintain it there for such a long distance, for the high ground immediately below confines it to below Tiptonville, and the New Madrid prairies on the right bank of the river prevent its overflow into the St. Francis bottoms. Thus the building of 20 miles of levee will practically hold the water during floods within the banks for a distance of 50 miles, and in this stretch of river there are a number of shoal places. As the volume restrained during maximum flood is 200,000 cubic feet and at mean flood about 70,000 cubic feet, I am of the opinion that the effect will be to keep the bars lower and improve low-water navigation.

Very respectfully, your obedient servant,

Capt. S. W. ROESSLER,
Corps of Engineers, U. S. A.

W. M. REES,
Assistant Engineer.



APPENDIX Y.

REMOVING SNAGS AND WRECKS FROM MISSISSIPPI RIVER; IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND ILLINOIS RIVERS, OF HARBOR AT ST. LOUIS, OF OSAGE AND GASCONADE RIVERS, MISSOURI, AND OF KASKASKIA RIVER, ILLINOIS.

REPORT OF MAJOR A. M. MILLER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|---|-------------------------------|
| 1. Removing snags and wrecks from the Mississippi River. | 3. Harbor at St. Louis, Mo. |
| 2. Mississippi River, between the Ohio and Illinois rivers. | 4. Gasconade River, Missouri. |
| | 5. Osage River, Missouri. |
| | 6. Kaskaskia River, Illinois. |
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UNITED STATES ENGINEER OFFICE,
St. Louis, Mo., July 16, 1891.

GENERAL: I have the honor to forward herewith annual reports for the fiscal year ending June 30, 1891, for the works under my charge.

Very respectfully, your obedient servant,

A. M. MILLER,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Y 1.

REMOVING SNAGS AND WRECKS FROM MISSISSIPPI RIVER.

The work for the fiscal year consisted in the removal of snags, logs, and leaning trees between the mouth of the Missouri River and Donaldsonville, La.

The river was divided into two districts, the first extending from the mouth of the Missouri River to Memphis, Tenn., and the second from Memphis, Tenn., to Donaldsonville, La. The snag boat *H. G. Wright* was assigned to work in the first district, and the snag boat *J. N. Maccomb* to the second district.

The *Wright* began work on August 1, 1890, and worked continuously until March 31, 1891; one trip between St. Louis, Mo., and Vicksburg, Miss., was also made during the month of May, 1891.

The *Macomb* began work on August 15, 1890, and remained in commission until March 31, 1891.

The work accomplished by the snag boats is given in the following table:

Name of snag boat.	Snags pulled.	Trees cut.	Drift piles removed.	Miles run.
H. G. Wright	1,720	10,511	13	8,119
J. N. Macomb	1,724	10,805	24	8,954
Total	3,450	21,316	37	17,073

Much needed repairs were made to both of the snag boats. An electric-light plant was placed on the *Wright* and new boilers were ordered for the *Macomb*. All repairs will be completed, and both boats will be ready to be put in commission as soon as the needs of commerce may require.

The work accomplished by the snag boats is of great benefit to the navigation of the river. Formerly the wreck of steamboats by running at snags was of frequent occurrence, but since the snag boats have been at work it is almost unheard of.

An annual appropriation having been made for this work of an amount not to exceed \$100,000, the snag boats will be put in commission and will patrol the river whenever necessary, and will keep the channel clear of obstructions.

The amount expended on this work during the fiscal year ending June 30, 1891, was \$92,470.98. A detailed statement of the expenditures is given in the accompanying tables, Nos. 1 and 2.

Money statement.

Amount drawn under section 7, act of August 11, 1888	\$92,500.00
June 30, 1891, amount expended during fiscal year	92,470.97
July 1, 1891, balance unexpended	29.03
July 1, 1891, amount available for fiscal year 1891-'92	100,000.00

TABLE NO. 1.—Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, as required by section 7 of the river and harbor act of August 11, 1888.

Month or quarter.	Abstract.	Voucher.	To whom paid.	For what paid.	Amount.
1890.					
July	A	1	Excelsior Manufacturing Co.	Outfit, etc.	\$7.00
		2	Anchor Line Store	Outfit and supplies	76.88
		3	Ewald Iron Co.	Supplies	21.67
		4	Rankin & Fritsch Foundry and Machine Co.	Steam pump	275.00
		5	The W. A. Bonsack Lumber Co.	Lumber	246.11
		6	Brislin-Sheble Manufacturing Co.	Casting	10.50
		7	Huse & Loomis Ice and Transportation Co.	Ice	59.08

TABLE NO. 1.—Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.—Continued.

Month or quarter.	Abstract.	Voucher.	To whom paid.	For what paid.	Amount.
1890.					
July	A	8	Hired men	Services ..	\$784.95
		9	do	do ..	1,110.33
		10	do	do ..	1,163.82
Aug	A	11	Sundry persons	Subsistence ..	53.05
		1	St. Louis, Iron Mountain and Southern Railroad ..	Railroad ticket ..	12.25
		2	Thomas J. Connor	Covering boilers ..	158.40
		3	Elwell & Tatum Com. Co. ..	Subsistence ..	44.63
		4	David Nicholson	do ..	710.97
		5	Francis Whittaker & Sons ..	do ..	238.61
		6	Henry A. Koettker	do ..	106.55
		7	Gust. Blachoff	do ..	263.07
		8	Fulton Iron Works	Casting ..	10.90
		9	Ward & Brady	Outfit and supplies ..	803.27
		10	Peterson & Homes	do ..	34.45
		11	Geo. A. Rubelmann Hardware Co. ..	do ..	5.50
		12	The Western Brass Manufacturing Co. ..	Supplies ..	19.25
		13	N. O. Nelson Manufacturing Co ..	do ..	32.06
		14	Anchor Line Store	do ..	68.17
		15	Pat. Norton	Repairing furnace ..	16.50
		16	Cairo City Coal Co	Coal ..	79.18
		17	Himmelberger & Friant	Sawing lumber ..	5.00
		18	Ewald Iron Co	Supplies ..	122.19
		19	Western Coal and Tow Co ..	Coal ..	158.33
		20	Buxton & Skinner Stationery Co. ..	Stationery ..	18.58
		21	The W. A. Bonsack Lumber Co ..	Lumber ..	40.46
Sept	C	1	Hired men	Services ..	753.00
		2	Pittsburg Coal Co	Coal ..	270.00
		3	Matt. Monaghan & Co	Subsistence ..	193.92
		4	Cairo City Coal Co	Coal ..	96.00
		5	James Smith	Services ..	50.00
		6	Hired men	do ..	1,820.00
		7	do	do ..	319.00
		8	do	do ..	1,573.50
		9	do	do ..	264.17
		10	Maj. A. M. Miller	Mileage ..	137.97
		11	Sundry persons	Subsistence ..	103.69
		12	do	do ..	66.30
		13	F. A. Dicks	Rosin ..	4.15
		14	Pittsburg Coal Co	Coal ..	435.00
		15	Peatross, Cameron & Co ..	do ..	114.45
		16	Anchor Line Store	Outfit and supplies ..	409.05
		17	Gust. Blachoff	Subsistence ..	208.53
		18	Goodyear Rubber Co	Hose ..	146.07
		19	Consolidated Coal Co. of St. Louis ..	Coal ..	140.00
		20	Ewald Iron Co	Supplies ..	124.79
		21	Francis Whittaker & Sons ..	Subsistence ..	117.87
		22	William Barr Dry Goods Co ..	Outfit, etc. ..	78.97
		23	Simmons Hardware Co	do ..	82.57
		24	A. C. Dunlevy	do ..	66.93
		25	N. O. Nelson Manufacturing Co. ..	Outfit and supplies ..	41.47
		26	Henry A. Koettker	Subsistence ..	17.45
		27	J. S. Merrell Drug Co	Medicines ..	26.12
		28	American Silk Manufacturing Co ..	Supplies ..	12.70
		29	Elwell & Tatum Commission Co. ..	Subsistence ..	11.25
		30	Peterson & Homes	Outfit ..	10.10
		31	Meyer Brothers Drug Co	Medicines ..	8.66
		32	Thomas J. Connor	Asbestos cement ..	7.00
		33	David Nicholson	Subsistence ..	534.11
		34	Sundry persons	do ..	272.68
		35	do	Fuel ..	79.60
		36	A. Lea & Co	Coal ..	98.00
		37	Matt. Monaghan & Co	Lumber, etc. ..	5.40
		38	Ward & Brady	Outfit and supplies ..	502.85
		39	Albert B. Bowman	Lathe ..	227.20
		40	A. C. Dunlevy	Stove castings, etc ..	14.12
		41	The W. A. Bonsack Lumber Co ..	Lumber ..	179.20
		42	James Sweeney	Outfit, etc. ..	27.15
		43	McKinley & Co	Coal ..	9.00
		44	Consolidated Coal Co. of St. Louis ..	do ..	96.15
		45	Peatross, Cameron & Co	do ..	165.90
		46	Leyser & Hafner	Rubber boots ..	12.00
		47	Broderick & Bascom Rope Co. ..	Tiller rope ..	68.58
		48	Huse & Loomis Ice and Transportation Co. ..	Ice ..	275.55
		49	Cairo City Coal Co	Coal ..	74.30
		50	James A. Tappan	Coal, etc ..	182.50

2082 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

TABLE NO. 1.—Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.—Continued.

Month or quarter.	Abstract.	Voucher.	To whom paid.	For what paid.	Amount.
1890.					
Sept	C	51	George Traub & Co	Subsistence	\$110.53
		52	Matt. Monaghan & Co	do	155.96
		53	William Barr Dry Goods Co	Repairs	9.50
		54	James Smith	Services	55.00
		55	Hired men	do	753.00
		56	do	do	1,684.00
		57	do	do	405.50
		58	do	do	1,750.33
		59	do	do	341.50
		60	do	do	40.67
1891.					
Second quarter.	C	1	Sundry persons	Subsistence	234.55
		2	do	Fuel	21.00
		3	do	Subsistence	192.59
		4	do	do	120.23
		5	Pittsburg Coal Co	Coal	790.00
		6	Francis Whittaker & Sons	Subsistence	191.42
		7	Elwell & Tatum Commission Co	do	27.97
		8	David Nicholson	Subsistence, etc.	714.01
		9	Lammert Furniture Co	Outfit	13.16
		10	Branch-Crookes Saw Co	do	28.80
		11	Simmons Hardware Co	Outfit, etc.	8.16
		12	E. A. Hitchcock, receiver	Coal	276.25
		13	Consolidated Coal Co. of St. Louis	do	70.00
		14	Blattner & Adam	Supplies .....	.60
		15	Albert B. Bowman	do	20.80
		16	F. L. McGinness Painting Co	do	24.55
		17	The W. A. Bonsack Lumber Co	Lumber	65.80
		18	Ewald Iron Co	Supplies	28.17
		19	J. D. Lawnin	Lumber	5.76
		20	W. C. Postal	Coal	42.00
		21	N. O. Nelson Manufacturing Co	Outfit, etc.	847.25
		22	Huse & Loomis Ice and Transportation Co.	Ice	62.20
		23	Peatross, Cameron & Co	Coal	167.65
		24	J. H. Coffin & Co	Outfit and supplies ..	106.25
		25	A. R. Taylor & Co	Stationery	11.35
		26	The Oliver-Finnie Grocer Co	Subsistence	434.72
		27	Hired men	Services	603.00
		28	do	do	1,738.66
		29	do	do	385.00
		30	do	do	1,630.33
		31	do	do	369.17
		32	do	do	87.83
		33	James Smith	do	55.00
		34	Consolidated Coal Co. of St. Louis	Coal	98.00
		35	E. A. Hitchcock, receiver	do	138.12
		36	Cairo City Coal Co	do	161.00
		37	Pittsburg Coal Co	do	255.00
		38	Matt. Monaghan & Co	Subsistence	139.83
		39	Gust. Bischoff	do	266.80
		40	Elwell & Tatum Commission Co	do	16.81
		41	Sundry persons	do	141.16
		42	Matt. Monaghan & Co	do	174.90
		43	Memphis Machine Co	Supplies	7.50
		44	A. Boschert & Co	Ice	25.32
		45	Fulton Iron Works	Castings, etc.	61.07
		46	G. Traub & Co	Subsistence	51.36
		47	Pittsburg Coal Co	Coal	420.00
		48	James A. Tappan	do	300.00
		49	A. Lea & Co	do	98.00
		50	Sundry persons	Subsistence	109.94
		51	do	Fuel	21.00
		52	Parker, Ritter, Nicholls Stationery Co	Stationery	18.00
		53	Modart Patent Pulley Co	Supplies	51.85
		54	Francis Whittaker and Sons	Subsistence	134.03
		55	Ward & Brady	Outfit and supplies ..	266.02
		56	Peatross, Cameron & Co	Coal	202.65
		57	Fulton Iron Works	Castings	243.50
		58	J. A. Fay & Co	Supplies	15.00
		59	Pond Engineering Co	do	114.40
		60	Branch-Crookes Saw Co	Outfit	12.00
		61	J. Kennard & Sons Carpet Co	do	35.00
		62	M. M. Buck & Co	do	2.10
		63	Day Rubber Co	do	18.00
		64	Francis Whittaker & Sons	Subsistence	73.19

TABLE NO. 1.—Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.—Continued.

Month or quarter.	Deduct.	Voucher.	To whom paid.	For what paid.	Amount.
1891.					
Second quarter.	C	65	Ewald Iron Co.	Supplies.	\$7.74
		66	The W. A. Bonsack Lumber Co.	Lumber.	74.11
		67	David Nicholson.	Subsistence.	274.31
		68	Consolidated Coal Co. of St. Louis.	Coal.	140.00
		69	Sundry persons.	Subsistence.	92.43
		70	Elwell & Tatum Commission Co.	do.	66.12
		71	Cairo City Coal Co.	Coal.	92.00
		72	E. A. Hitchcock, receiver.	do.	151.12
		73	N. O. Nelson Manufacturing Co.	Supplies.	38.66
		74	Page & Tolacz.	do.	24.05
		75	Simmons Hardware Co.	Outfit and supplies.	28.10
		76	Anchor Line Store.	do.	252.74
		77	Hired men.	Services.	603.00
		78	do.	do.	1,669.34
		79	do.	do.	422.33
		80	do.	do.	1,330.00
		81	do.	do.	739.33
		82	Gust. Bischoff.	Subsistence.	171.96
		83	James Smith.	Services.	55.00
		84	The Oliver-Finnie Grocer Co.	Outfit and subsistence.	67.75
		85	Sundry persons.	Subsistence.	278.44
		86	do.	do.	71.56
		87	Matt. Monaghan & Co.	do.	119.76
		88	Pittsburg Coal Co.	Coal.	790.00
		89	Jas. A. Tappan.	do.	120.00
		90	J. H. Coffin & Co.	Supplies.	86.95
		91	Charles Miller.	Reducer.	6.50
		92	J. F. Irvine.	Coal.	105.00
		93	Western Coal and Tow Co.	do.	10.85
		94	Matt. Monaghan & Co.	Subsistence, etc.	117.53
		95	Pittsburg Coal Co.	Coal.	292.50
		96	Pond Engineering Co.	Exhaust head.	180.00
		97	Hired men.	Services.	603.00
		98	do.	do.	1,775.00
		99	do.	do.	367.50
		100	do.	do.	1,770.00
		101	do.	do.	315.33
		102	James Jackson.	do.	23.00
		103	Sundry persons.	Subsistence.	144.75
		104	do.	Fuel.	53.50
		105	James Smith.	Services.	55.00
		106	Ward & Brady.	Outfit and supplies.	71.36
		107	Anchor Line Store.	do.	235.33
		108	Consolidated Coal Co. of St. Louis.	Coal.	70.00
		109	Cairo City Coal Co.	do.	221.40
		110	E. A. Hitchcock, receiver.	do.	107.49
		111	Elwell & Tatum Commission Co.	Subsistence.	46.61
		112	Gust. Bischoff.	do.	119.84
		1	Sundry persons.	do.	228.82
		2	do.	do.	137.71
		3	do.	do.	66.08
		4	G. Traub & Co.	do.	120.00
		5	Jas. A. Tappan.	Coal.	97.84
		6	Maj. A. M. Miller.	Mileage.	548.90
		7	J. H. Coffin & Co.	Outfit and supplies.	561.00
		8	The Oliver-Finnie Grocer Co.	Subsistence.	153.61
		9	Matt. Monaghan & Co.	do.	702.50
		10	Pittsburg Coal Co.	Coal.	70.00
		11	Peatross, Cameron & Co.	do.	80.00
		12	Wood, Bodley & Co.	do.	122.50
		13	J. F. Irvine.	do.	52.50
		14	John F. Irvine & Son.	do.	270.00
		15	Pittsburg Coal Co.	do.	270.00
		16	Charles Miller.	Supplies.	6.50
		17	B. D. Wood & Sons.	Coal.	80.00
		18	Peatross, Cameron & Co.	do.	190.80
		19	Gust. Bischoff.	Subsistence.	118.48
		20	Elwell & Tatum Commission Co.	do.	49.02
		21	Francis Whittaker & Sons.	Subsistence.	162.31
		22	J. Kennard & Sons Carpet Co.	Outfit repairs.	14.15
		23	Ward & Brady.	Outfit supplies.	251.35
		24	Simmons Hardware Co.	do.	13.41
		25	The W. A. Bonsack Lumber Co.	Lumber.	45.19
		26	Fulton Iron Works.	Machinery, etc.	336.97
		27	Buxton & Skinner Stationery Co.	Stationery.	13.60
		28	Sundry persons.	Subsistence.	58.28
		29	James Smith.	Services.	55.00
Third quarter.	D				

2084 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

TABLE NO. 1.—Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.—Continued.

Month or quarter.	Abstract.	Voucher.	To whom paid.	For what paid.	Amount.
1891.					
Third quarter.	D	29	E. A. Hitchcock, receiver.	Coal	\$105.63
		30	Hired men	Services	1,778.00
		31	do.	do	843.50
		32	do.	do	603.00
		33	Consolidated Coal Co. of St. Louis	Coal	70.00
		34	Page & Tolkacz	Supplies	9.00
		35	David Nicholson	Subsistence, etc.	542.38
		36	Hired men	Services	1,330.00
		37	do.	do	736.00
		38	Sundry persons	Subsistence.	256.12
		39	do.	do	35.13
		40	Cairo City Coal Co.	Coal	95.90
		41	G. Traub & Co.	Subsistence.	69.35
		42	Matt. Monaghan & Co.	do	58.43
		43	Jas. A. Tappan	Coal.	180.00
		44	Pittsburg Coal Co.	do.	725.00
		45	Ewald Iron Co.	Supplies	15.39
		46	Goodyear Rubber Co.	Outfit	12.00
		47	Sundry persons	Fuel	15.00
		48	do.	Subsistence	42.40
		49	do.	do	122.03
		50	Himmelberger & Friant	Sawing logs.	16.00
		51	Smith Torrence	Supplies	6.75
		52	G. D. Williamson	do	4.00
		53	Hired men	Services	603.00
		54	do.	do	1,817.00
		55	do.	do	273.00
		56	James Smith.	do	55.00
		57	Hired men.	do	1,314.00
		58	do.	do	800.00
		59	Sundry persons	Subsistence.	270.21
		60	do.	do	49.30
		61	The W. A. Bonsack Lumber Co	Lumber	19.00
		62	Ward & Brady.	Outfit and supplies	104.55
		63	Simmons Hardware Co.	do	17.25
		64	Wills & Crumpton.	Binding maps.	7.50
		65	Consolidated Coal Co. of St. Louis	Fuel	274.35
		66	Gust. Bischoff.	Subsistence.	210.80
		67	Elwell & Tatum Com. Co	do	28.15
		68	Fulton Iron Works.	Castings, etc.	11.70
		69	Matt. Monaghan & Co	Subsistence.	88.09
		70	The Oliver-Pinnie Grocer Co.	Subsistence, etc.	319.51
		71	J. H. Coffin & Co.	Supplies	38.50
		72	Cairo City Coal Co.	Coal	251.12
		73	Pittsburg Coal Co.	do	572.50
		74	Peatross, Cameron & Co	do	190.00
		75	do.	do	72.00
		76	Jas. A. Tappan.	Coal, etc.	217.50
		77	Matt. Monaghan & Co.	Subsistence	95.40
		78	J. H. Coffin & Co	Supplies	4.00
		79	Jas. A. Tappan.	Coal	120.00
		80	Pittsburg Coal Co.	do	292.50
		81	E. A. Hitchcock, receiver	do	121.87
		82	C. E. Williams	do	56.87
		83	Dan Shea & Co.	Repairs.	50.00
		84	Chas. E. Butler.	Timber	34.00
		85	Pittsburg Coal Co	Coal	295.00
		86	St. Louis, Iron Mountain and Southern Rwy. Co.	Railroad ticket	12.25
		87	Sundry persons	Subsistence.	36.43
		88	Albert L. Butler	Timber	24.00
		89	Cairo City Coal Co.	Coal	120.00
		90	Hired men	Services	603.00
		91	do.	do	1,711.67
		92	do.	do	232.33
		93	do.	do	657.33
		94	do.	do	1,340.67
Fourth quarter.	D	1	Sundry persons	Subsistence.	230.29
		2	do.	do	114.48
		3	do.	do	175.00
		4	Western Coal and Tow Co.	Coal	77.00
		5	Consolidated Coal Co. of St. Louis	do	69.88
		6	Bryden Coal and Coke Co.	do	154.37
		7	E. A. Hitchcock, receiver.	do	110.95
		8	Gust. Bischoff.	Subsistence.	34.36
		9	Francis Whittaker & Sons.	do	25.88
		10	Chris-Sharp Commission Co	do	147.48
		11	David Nicholson	do	

TABLE No. 1.—Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.—Continued.

Month or quarter.	Abstract.	Voucher.	To whom paid.	For what paid.	Amount.
1891.					
Fourth quarter.	D	12	Wrought Iron Range Co.....	Outfit.....	\$137.50
		13	Peterson & Homes.....	do.....	11.28
		14	Wm. Barr Dry Goods Co.....	do.....	10.00
		15	Ward & Brady.....	Outfit and supplies.....	328.39
		16	A. Boschert & Co.....	Ice.....	24.95
		17	Charles Miller.....	Shells for heaters.....	153.01
		18	George Peisch & Bro.....	Supplies.....	11.05
		19	Charles T. Fitzpatrick.....	Subsistence.....	22.35
		20	J. H. Coffin & Co.....	Supplies.....	36.00
		21	Robert Washington.....	Services.....	27.00
		22	Charles E. Butler.....	Locust timber.....	21.00
		23	N. O. Nelson Manufacturing Co.....	Steam-fittings.....	6.60
		24	Thomas J. Connor.....	Covering boilers.....	22.90
		25	Rankin & Fritsch F. & M. Co.....	Steam pump.....	80.00
		26	Ewald Iron Co.....	Steel.....	13.01
		27	Wrought Iron Range Co.....	Castings.....	6.84
		28	The W. A. Bonsack Lumber Co.....	Lumber.....	99.20
		29	Hired men.....	Services.....	603.00
		30	do.....	do.....	1,056.17
		31	do.....	do.....	101.16
		32	do.....	do.....	1,181.67
		33	New York Store Co.....	Paint.....	4.50
		34	F. W. Mott.....	Wood.....	3.00
		35	William Jarrett.....	Subsistence.....	18.00
		36	St. Louis, Iron Mountain and Southern Rwy. Co.....	Railroad ticket.....	12.25
		37	Owen Jackson.....	Services of James Jackson, deceased.....	28.00
		38	Consolidated Coal Co. of St. Louis.....	Coal.....	128.10
		39	Peterson & Homes.....	Outfit.....	39.35
		40	Missouri Tent and Awning Co.....	Engineer flag.....	18.80
		41	Gust. Bischoff.....	Subsistence.....	378.17
		42	John Gorman & Bro.....	do.....	21.75
		43	Francis Whittaker & Sons.....	do.....	130.92
		44	Mellier Drug Co.....	Medicines.....	6.40
		45	Ward & Brady.....	Supplies.....	85.55
		46	N. O. Nelson Manufacturing Co.....	do.....	12.29
		47	Ewald Iron Co.....	Iron.....	20.06
		48	James Sweeney & Son.....	Covering kitchen floor.....	79.36
		49	Wrought Iron Range Co.....	Range fittings.....	14.00
		50	Maj. A. M. Miller.....	Mileage.....	124.48
		51	Cairo City Coal Co.....	Coal.....	72.00
		52	Pittsburg Coal Co.....	do.....	525.00
		53	Jas. A. Tappan.....	do.....	210.00
		54	Peatross, Cameron & Co.....	do.....	120.00
		55	Matt. Monaghan & Co.....	Subsistence.....	195.94
		56	Sundry persons.....	do.....	97.94
		57	Hired men.....	Services.....	603.00
		58	do.....	do.....	1,793.17
		59	do.....	do.....	356.00
		60	do.....	do.....	1,028.17
		61	James Smith.....	do.....	40.00
		62	Sundry persons.....	Subsistence.....	182.90
		63	do.....	do.....	141.03
		64	Ward & Brady.....	Outfit and supplies.....	182.96
		65	Anchor Line Store.....	do.....	124.72
		66	Simmons Hardware Co.....	Outfit.....	2.90
		67	Consolidated Coal Co. of St. Louis.....	Coal.....	92.50
		68	E. A. Hitchcock, receiver.....	do.....	65.00
		69	W. A. Bonsack Lumber Co.....	Lumber.....	29.34
		70	Fulton Iron Works.....	Re-pairing machinery.....	366.40
		71	Charles Miller.....	Water tanks, etc.....	42.50
		72	Peterson & Homes.....	Crockery.....	3.00
		73	Gust. Bischoff.....	Subsistence.....	236.44
		74	David Nicholson.....	do.....	556.10
		75	Standard Stamping Co.....	Tin ware.....	12.55
		76	Edward Williams.....	Services.....	7.50
		77	Westinghouse Electric and Manufacturing Co.....	Electric-light plant.....	1,613.88
		78	Pond Engineering Co.....	Pump plungers.....	62.70
		79	Mitchell Furniture Co.....	Outfit.....	46.50
		80	Peterson & Homes.....	do.....	54.27
		81	Chas. W. Barstow.....	Outfit and supplies.....	115.76
		82	Simmons Hardware Co.....	do.....	77.09
		83	Anchor Line Store.....	do.....	604.08
		84	N. O. Nelson Manufacturing Co.....	Supplies.....	34.65
		85	Ward & Brady.....	do.....	44.30

2086 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

TABLE No. 1.—Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.—Continued.

Month or quarter.	Abstract.	Voucher.	To whom paid.	For what paid.	Amount.
1891. Fourthquarter.	D	86	Kupferle Bros. Manufacturing Co.....	Supplies.....	\$20.30
		87	A. S. Aloe & Co.....	do.....	22.93
		88	M. M. Buck & Co.....	Outfit.....	120.06
		89	Charles Scofield.....	Repairing boilers.....	11.25
		90	Ernst Winkler.....	Subsistence.....	16.56
		91	Gust. Bischoff.....	do.....	187.50
		92	Hired men.....	Services.....	553.00
		93	Wrought Iron Range Co.....	Repairs.....	15.62
		94	Sundry persons.....	Subsistence.....	99.30
		95	Hired men.....	Services.....	51.00
Total amount expended.....					92,470.97

TABLE No. 2.—Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, as required by section 7 of the river and harbor act of August 11, 1888.

	1890.					
	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Office expenses.....	\$553.25	\$18.56	\$1,106.00	\$403.60	\$18.00	\$806.00
Supervision.....	211.70		537.97	200.00		400.00
Expenses of snag boat <i>H. G. Wright</i> :						
Crew.....	1,153.82		4,271.50	2,121.66		4,264.17
Outfit.....		363.82	338.12	67.28	321.81	240.33
Fuel.....		79.18	848.90	1,061.37	502.12	702.24
Subsistence.....	27.05	1,120.52	668.25	1,618.76	614.99	647.19
Supplies.....		300.25	22.32	3.66	178.45	73.36
Repairs.....	66.59	441.15	28.12	185.35	641.16	186.50
Miscellaneous.....		17.25	8.66			
Expenses of snag boat <i>J. N. Macomb</i> :						
Crew.....	1,110.33		3,927.17	2,087.33		4,177.66
Outfit.....	281.44	57.65	851.46	876.78	51.85	365.00
Fuel.....		117.18	884.50	957.65	922.05	1,015.00
Subsistence.....	85.08	243.31	1,419.60	1,126.75	185.39	502.51
Supplies.....	6.75	41.15	306.12	64.20		55.75
Repairs.....	282.38	146.53	511.16	20.02	15.00	31.20
Miscellaneous.....		1.75	26.12	11.35		
Storeboat <i>Abert</i>			105.00	55.00		110.00
Totals.....	3,778.39	2,948.32	15,860.97	10,862.74	3,451.42	13,246.91

	1891.						Totals.
	Jan.	Feb.	Mar.	Apr.	May.	June.	
Office expenses.....	\$416.60	\$403.00	\$403.00	\$403.00		\$756.00	\$5,287.03
Supervision.....	297.84	200.00	200.00	200.00	\$124.48	400.00	2,771.99
Expenses of snag boat <i>H. G. Wright</i> :							
Crew.....	2,121.50	2,090.00	1,892.00	1,141.67		2,200.17	21,258.49
Outfit.....	29.20	12.00	18.20	235.28	53.15	1,888.91	3,568.08
Fuel.....	484.63	110.90	981.71	133.87	1,058.10	135.00	6,098.02
Subsistence.....	1,082.19	164.43	370.78	285.99	712.60	803.28	8,116.03
Supplies.....	129.39	4.00	27.90	67.83	50	137.51	945.17
Repairs.....	519.87	38.14	200.60	437.33	183.53	414.54	3,342.88
Miscellaneous.....			12.25		6.40		44.58
Expenses of snag boat <i>J. N. Macomb</i> :							
Crew.....		2,066.00	2,771.33	2,525.00	28.00	1,035.67	19,728.49
Outfit.....	443.73			16.10		83.77	2,697.78
Fuel.....	1,379.50	905.00	1,579.50	342.38			8,103.16
Subsistence.....	992.21	419.03	720.31	424.70	129.62	609.64	6,858.15
Supplies.....	87.57				6.90	33.97	640.22
Repairs.....	11.25		48.99	184.74	20.83	1,161.50	2,433.60
Miscellaneous.....	6.35		7.50		12.25		65.32
Storeboat <i>Abert</i>	55.00	55.00	52.00	40.00		40.00	512.00
Totals.....	8,056.63	6,467.50	9,323.88	6,437.89	2,336.36	9,699.96	92,470.97

Y 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND ILLINOIS RIVERS.

PROJECT.

The object of the improvement is to obtain a minimum depth at low water of 6 feet from the mouth of the Illinois River to St. Louis, a distance of 41 miles, and 8 feet from St. Louis to the mouth of the Ohio River, a distance of 191 miles, the natural depth at low water being in many cases from $3\frac{1}{2}$ to 4 feet. The initial point of the work for the lower portion is St. Louis, the programme being to make the work continuous, working downstream from that city. Work at detached points has also been carried on under allotments specially made by law for the improvement of landings and the protection of local interests.

The plan of general improvement contemplates a reduction of the river to an approximate width of 2,500 feet below St. Louis, the natural width being in many cases from 1 to $1\frac{1}{2}$ miles, and the protection of the alluvial banks from erosion. The methods employed are to build up new banks with the solid matter caught from the river itself by means of hurdles and revetment of the banks, both new and old, when necessary.

ORGANIZATION.

The organization of the engineering staff during the season was as follows:

A supervising engineer was assigned to the general supervision of all the works and of the supply depot. His office was in St. Louis and his duties were to advise and direct the resident engineers and to have especial charge of the supply of brush, stone, and piles, and of the towboat and barges engaged on the work.

The resident engineer was provided with quarters and an office at the work. His duties were to have immediate direction of the work of construction; to make such surveys and observations as might be required to keep the progress map, upon which all work was to be located, as fast as constructed; to keep the journal and other records of the work; to prepare pay rolls; to render quarterly property returns, semi-annual and annual reports to the officer in charge, forwarding them through the superintending engineer.

The superintending engineer was Mr. D. M. Currie. Resident engineers: At Ste. Genevieve, Mr. William S. Mitchell; at Rush Tower, and for the procurement of brush, Mr. C. D. Lamb.

WORK ACCOMPLISHED.

Owing to the lateness of the passage of the river and harbor bill, September 19, 1890, no work of construction was attempted during the fall, but contracts were entered into for the supply of material and the building of 13 model barges and extensive repairs to plant.

The amount appropriated by the river and harbor bill of 1890 was \$400,000. Of this amount \$50,000 was to be expended in the completion of the work at Alton and \$50,000 for improving the river at St. Genevieve, in the State of Missouri.

The approved project for the expenditure of this amount contemplated work as follows:

For Alton Harbor (by law).....	\$50,000
For Ste. Genevieve (by law).....	50,000
Repair and purchase of plant.....	40,000
Contingencies and repair of old work.....	15,000
Rush Tower, or new project	245,000
	<hr/> 400,000

ALTON.

The work at Alton consists of the extension of the present submergeable stone dike for a distance of 2,800 feet. The object of the work is to prevent the formation of a bar in front of the landing at Alton by directing the flow of water at low stages along the river front at that place. A contract was entered into for this work with Mr. H. S. Brown, of Quincy, Ill., under date of January 28, 1891. Owing to the lateness of the season and the danger of interference with the work by running ice, no work could be undertaken here during the fall or winter, and up to the 30th of June the stage of water has been too high to begin work; the contractor is prepared to go to work as soon as the stage of water will permit. The amount expended was \$51.22.

RUSH TOWER.

Work was begun at the head of this section of the river about June 15, and is still in progress. Owing to the extreme depth of water found near the shore at the prevailing high stage, but little work could be accomplished in the way of hurdles. Two hurdles, Nos. 4 and 5, were located and partially built, and 600 feet of bank protection was placed in position. Work will be continued here as long as the season will permit.

The river here at high water has shown a tendency to make a crossing higher up than the channel of last year, and if this channel persists at low water a slight modification of the project here may be necessary.

The protection of the bank where work has been commenced, at a point about 1 mile below Calico Island, is necessary, as it has in one place caved so far as to be within 50 feet of the base of the levee which protects the bottom lands from overflow. The amount expended was \$3,926.06.

ST. GENEVIEVE.

The work at this point consisted in the construction of a series of hurdles on the Illinois side of the river in order to prevent the channel leaving Little Rock, the landing for the town of St. Genevieve, and also to contract the river to a width of 2,500 feet.

Work was begun here on May 22, and continued up to the close of the fiscal year. A system of four hurdles was projected, but on an examination of the locality at the commencement of work it was found that the bar at the foot of Turkey Island had worked downstream so far as to render the construction of the upper hurdle unnecessary. Three hurdles, Nos. 2, 3, and 4, were constructed and practically completed; their lengths are, respectively, 1,500, 1,250, and 900 feet. Amount expended was \$9,830.55.

Improvement of Mississippi, between Illinois a

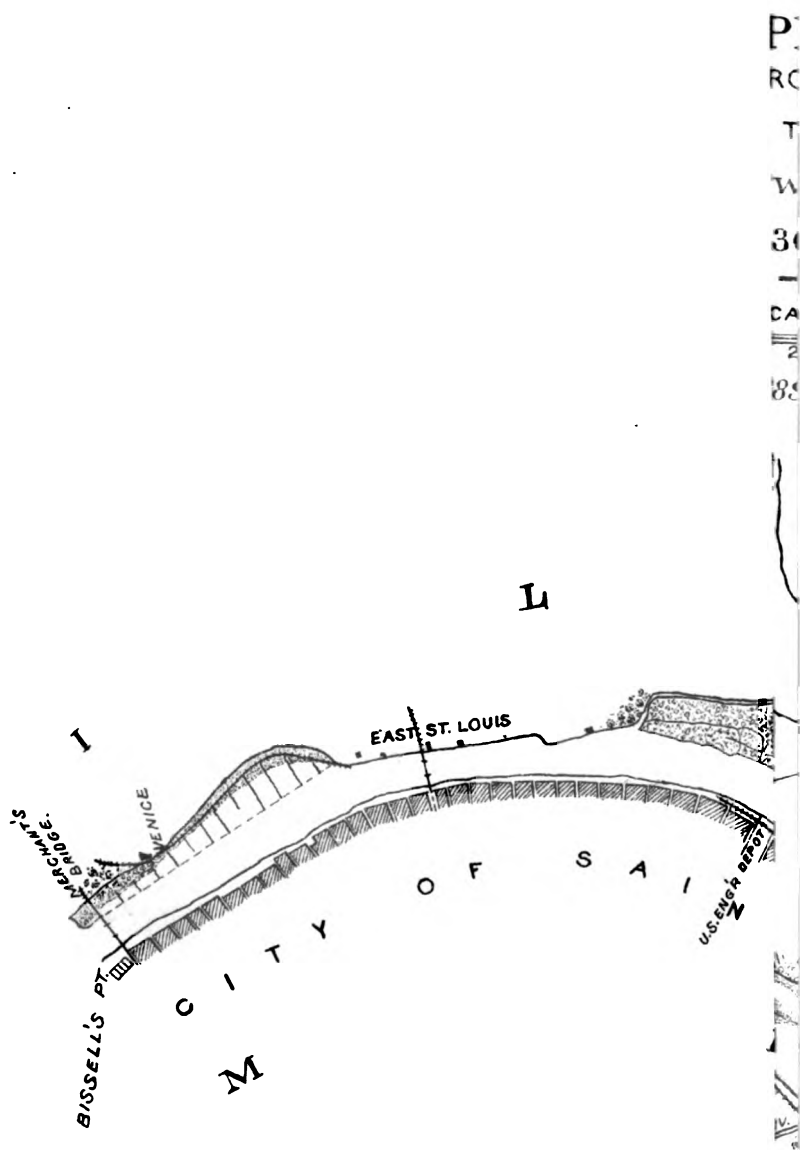


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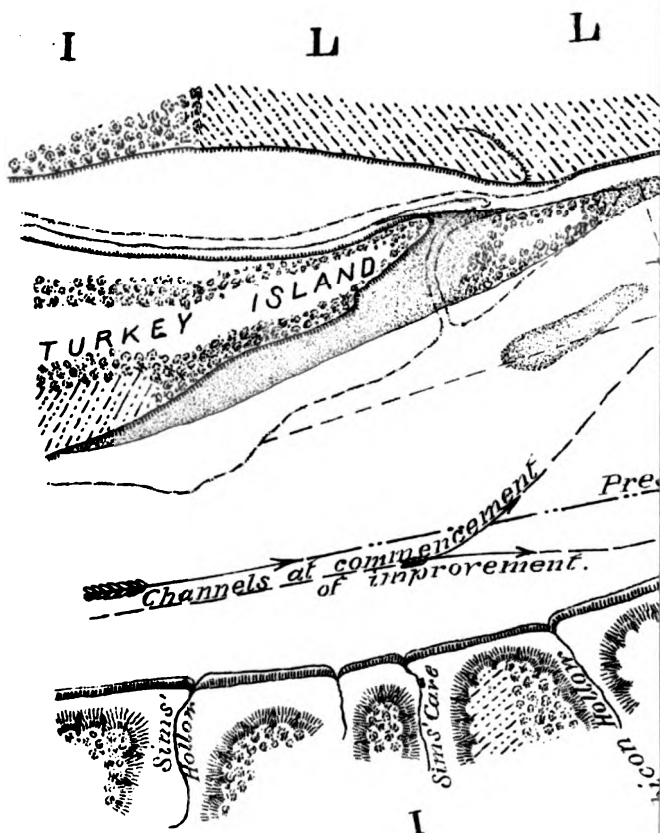
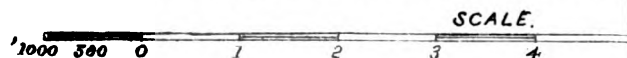
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MISSISSIPPI R

FROM
TURKEY ISLAND TO ST

Showing works of imp

*Bars are shown as they appear July 1891, at
Bars as they appeared in Aug. 1889, at stage 6.40 ft. ab*



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Photo-Lith. by A. HOEN & CO.

PLATES.

Plate I is a general map of the river from the Merchants Bridge to Pecco Island, and shows the location of the works, with the exception of the Alton dam. Plate II shows the work at St. Genevieve.

MATERIAL.

Brush and poles were obtained by hired labor, a royalty of 10 cents per cord being paid to owners of land where brush was cut. Stone was obtained from the Grafton Quarry Company at 45 cents per cubic yard, loaded on Government barges at their quarry. Rope, bolts, wire, spikes, nails, etc., were obtained by contract. Piles were obtained by contract with Mr. John Cleary, of Chester, at prices varying from 6 to 8 cents per linear foot, according to growth.

SUPPLY DEPOT.

The supply and subsistence department was under the immediate supervision of Mr. S. S. Van Norman. All supplies, except stone, brush, and piles, were delivered at the depot, foot of Arsenal street, St. Louis, and thence distributed on approved requisitions to the several works. In addition to this function of the depot it is a general repair shop and yard, where all repairs to plant not requiring dockage were made.

REPAIRS OF PLANT.

Necessary repairs were made to the steamer *Gen. Gillmore*, and to the pile drivers, barges, quarter boats, and all floating plant. Two stern-wheel steam towboats for light work about the hurdles, moving barges, and supplying piles, etc., were constructed. Fifteen pile drivers were taken on the ways at Mound City, Ill., and their hulls completely repaired, new hulls were built for 4 pile drivers, and all other necessary repairs made. Leads, side braces, ladders, and machinery were made; 19 model barges were taken out on the ways and repaired and calked up to lower draft line; new decks and other repairs were put on 11 barges. Twenty flats were built and provided with mattress ways; 51 skiffs and yawls repaired.

For details of this and other work reference is made to reports of assistants forwarded herewith as part of this report.

The present value of the property remaining to be distributed on installation account is given in the following table:

Class of property.	Balance June 30, 1890	Debits.	Credits.	Balance June 30, 1891.
Barges, model and flats	\$31,393.70	46,381.05	11,661.42	\$66,112.33
Machine shop	1,885.61	1,354.95	2,440.56	800.00
Boats, small	6,643.70	11,129.87	1,713.25	16,090.32
Boats, pile	20,969.83	28,665.25	3,693.75	45,941.33
Boats, portable	7,881.11	2,622.12	960.90	9,522.33
Steamer General Gillmore	11,815.45	13,076.04	13,384.70	11,506.79
Barges, steam		6,513.62		6,513.62
Boats, model	190.75			190.75
Supply depot	3,479.75	1,674.76	548.73	4,805.78
Boats and appliances	1,626.00	3,795.71	457.06	4,964.65
Boating outfit	9,306.97	1,635.11	950.66	9,991.42
Boat furniture	428.48		42.85	385.63
Boating instruments	471.61	32.25	47.16	456.70
Photographic apparatus	200.48			200.48
Total	96,273.44	116,880.73	35,901.04	177,253.13

GAUGES.

The gauges at Grafton and Gray's Point were read daily during the year. The readings are appended, marked A.

CONDITION OF THE RIVER.

The channel depths, as furnished by the Mississippi and Ohio Rivers Pilots' Association, for the year are appended, marked B. A full list of soundings could not be obtained, as the pilots' reports were not all preserved.

The river was open all winter and navigation was not interrupted by ice. This is the third successive winter with navigation uninterrupted.

The stage of water was lowest in December, January, and February, when it fell below standard low water; the highest stage was in June, when it reached a height of 19 feet above low water. The navigation of the river has been in a very good condition. The least depth met with in the portion of the river under improvement, a stretch of 30 miles from St. Louis, was 5 feet, found at Twin Hollows; this place soon deepened and a good channel of about 7 feet was maintained.

The locality, Twin Hollows, has been a difficult one for boats always; the works built here, however, for improving the channel have had a marked effect and the channel should be good and well defined this season. At Lucas', depths of 6 and 6½ feet were found in December, but soon scoured out to 7 and 8 feet. About the shoalest place in the river last season was at Perry's Towhead; this locality will be improved with the funds now available.

ESTIMATE.

The amount that can be profitably expended during the year ending June 30, 1893, is \$1,000,000. It is proposed to expend this sum in carrying out the programme heretofore adopted—that is, to carry on the work of improvement continuously from St. Louis downstream, reclaiming land by building up new banks, thus reducing the river to an approximate width of 2,500 feet, alluvial banks to be protected from erosion. It is proposed to obtain by this means a channel of at least 8 feet at low water. The depth now is liable to become as small as 4 feet, or even less in some places, and less at every locality where the width is more than 2,500 feet.

This general statement of the proposed application of the appropriation is as specific as the nature of the case admits. The changeable character of the river renders it impracticable to give in advance the exact locality where works will be required.

The original estimated cost of this work, as revised in 1883, was \$16,997,100; the aggregate amount appropriated to June 30, 1891, is \$4,529,600; the amount expended to June 30, 1890, \$4,032,422.

ABSTRACT OF APPROPRIATIONS MADE FOR THIS WORK.

By act of—

June 10, 1872.....	\$125, 000
March 3, 1873.....	200, 000
June 23, 1874.....	200, 000
March 3, 1875.....	200, 000
August 14, 1876.....	229, 600
June 18, 1878.....	240, 000
March 3, 1879.....	200, 000

By act of—

June 14, 1880.....	\$320, 000
March 3, 1881.....	620, 000
August 2, 1882.....	600, 000
July 5, 1884.....	520, 000
August 5, 1886.....	375, 000
August 11, 1888.....	300, 000
September 19, 1890.....	400, 000

Money statement.

July 1, 1890, balance unexpended.....	\$97, 177. 71
Amount appropriated by act approved September 19, 1890.....	400, 000. 00
	<hr/> 497, 177. 71
June 30, 1891, amount expended during fiscal year.....	96, 811. 87
	<hr/> 400, 365. 84
July 1, 1891, balance unexpended.....	
July 1, 1891, outstanding liabilities.....	\$20, 720. 86
July 1, 1891, amount covered by uncompleted contracts... ..	114, 727. 18
	<hr/> 135, 448. 04
July 1, 1891, balance available	264, 917. 80
<hr/>	
{ Amount (estimated) required for completion of existing project	12, 467, 500. 00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	1, 000, 000. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals received for furnishing lumber, opened October 3, 1890, by Maj. A. M. Miller, Corps of Engineers, St. Louis, Mo., under notice of 10 days, by circular letter dated September 23, 1890.

[Addresses of bidders: St. Louis, Mo.]

Kind.	Quantities.		F. Duff.	St. Louis Refrigerator and Wooden Gutter Company.	John J. Ganahl Lumber Company.	Eau Claire-St. Louis Lumber Company.	W. A. Bonsack.	Knapp, Stout & Co. Company.
	Pieces.	Feet.	Per M.	Per M.	Per M.	Per M.	Per M.	Per M.
White oak	476	26, 272	*\$23. 00	\$34. 00			\$35. 00	
	40	2, 317	*24. 00	34. 00			35. 00	
	202	6, 775	*25. 00	34. 00			35. 00	
	3	240	*26. 00	44. 00			35. 00	
	260	10, 920	*28. 00	44. 00			45. 00	
	90	600	*28. 00	44. 00			50. 00	
	915	47, 738	*29. 00	44. 00			45. 00	
	104	8, 493	*34. 00	34. 00			35. 00	
	30	3, 690	*34. 00	44. 00			45. 00	
White pine	46	5, 520	*30. 50	36. 00	35. 00		40. 00	
	46	2, 415	*28. 50	34. 00	35. 00		40. 00	
	60	1, 440	*20. 50	25. 00	30. 00		35. 00	
	20	6, 720	*32. 50	36. 00	40. 00		45. 00	
	20	4, 320	*31. 50	36. 00	37. 50		45. 00	
	60	7, 200	*25. 00	29. 00	32. 50		40. 00	
	40	5, 760	*26. 00	36. 00	37. 50		45. 00	
	70	560	51. 00	*30. 00	37. 50	45. 00		
	20	600	*51. 00	55. 00				
	34	776	*51. 00	55. 00	52. 50	52. 50		
	20	320	51. 00	55. 00	52. 50	*50. 00		
	20	467		*60. 00	65. 00			
	20	400	*22. 00	26. 00	22. 50	25. 00		
	500	15, 000	22. 50	25. 00	*17. 50	18. 50	37. 50	
		7, 000	18. 00	17. 50	16. 00	*14. 50		
		1, 000	21. 00	21. 00	18. 00	*16. 50		
		28, 000	15. 50	16. 00	15. 00	*14. 50		
		17, 500	24. 00	25. 00	25. 00	*18. 00		
		16, 800	40. 00	37. 50	36. 00		45. 00	\$30. 00
		12, 000	40. 00	37. 50	35. 00		45. 00	*30. 00
		112, 000	*40. 00	†37. 50	42. 00		45. 00	
		2, 000	29. 00	38. 00	35. 00	*17. 50		37. 50
		5, 500	21. 00	30. 00	19. 00	*19. 00		25. 00
		1, 000	21. 00	29. 00	18. 50	*17. 50		22. 50
Yellow pine	100	6, 667		40. 00	*37. 50		40. 00	
	11	1, 013	*28. 50	40. 00	30. 00	35. 00		
	8	512	23. 50	30. 00	25. 00	*22. 50		
	181	3, 877	21. 50	22. 50	25. 00	*20. 00		
	30	4, 320	*27. 50	40. 00	30. 00	35. 00		
	340	6, 987	19. 00	*15. 00	16. 00	16. 00		

*Awarded. Formal written contract entered into with F. Duff only; remainder purchased "under public notice of 10 days."

†Did not comply fully with specifications; the next lowest bid was therefore accepted.

2092 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of proposals received, in response to advertisement dated November 20, 1890, for furnishing piles, stone, manila and sisal rope, wire, nails, spikes, and screw bolts, opened December 20, 1890, by Maj. A. M. Miller, Corps of Engineers, St. Louis, Mo.

No.	Name and address of bidder.	Piles.					Stone, 30,000 cubic yards, per cubic yard.	Manila rope, 25,000 pounds, per pound.	Sisal rope, 7,000 pounds, per pound.	Wire, 50,000 pounds, per pound.	Nails, 18,000 pounds, per pound.	Spikes, 37,500 pounds, per pound.	Screw bolts, 30,000 pounds, per pound.
		5,500, 30 to 35 feet per foot.	7,000, 36 to 40 feet, 266,000 feet, per foot.	4,000, 41 to 45 feet, 172,000 feet, per foot.	3,300, 46 to 50 feet, 158,400 feet, per foot.	1,200, 51 to 60 feet, 66,000 feet, per foot.							
		Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
1	Lawrence Evers, St. Charles, Mo.	8	9	10	10½	11							
2	Daniel Kerwin, St. Louis, Mo.												2½
3	Benj. F. Johnston, St. Elmo, Ill.	8	8½	9	9½	10							
4	Mo. Lumber and Mining Co., Grandin, Mo.	8½	8½	9½	9½	13							
5	John W. Reno, New Madrid, Mo.	7	7	7	7	7							
6	Whitney Gilbreath, Ava, Ill., and James T. McClure, Wheatland, Ill.	6½	7	7½	8	8							
7	Harry E. Coffin, Memphis, Tenn.							11.42 100	8	3.15 100		*2.55 100	2.55 100
8	Ludlow-Saylor Wire Co., St. Louis, Mo.									3.25 100			
9	Grafton Quarry Co., St. Louis, Mo.						*45						
10	Leopold Methudy, St. Louis, Mo.	8½	8½	9½	10½	13½							2.65 100
11	Moran Bolt and Nut Manufacturing Co., St. Louis, Mo.												2.65 100
12	James J. Hawk, St. Louis, Mo.							12½	7.9 10	*3.05 100			
13	Louis Grund & Martin Lorenz, St. Louis, Mo.						64						
14	J. B. Morrell & Co., Brooklyn, N. Y.										2.1 20	3.1 10	3½
15	Augustus W. Benedict, St. Louis, Mo.							*11.15 100	{*7.67 100, *7.15 100}				
16	Ward & Brady, St. Louis, Mo.							13.15 10	8½			2.9 100	
17	Anchor Line Store, St. Louis, Mo.							12.73 100					2.65 100
18	M. M. Buck & Co. St. Louis, Mo.						13	7½	3.15 10	*2	2.73 100	2.65 100	
19	Berthold & Jennings, St. Louis, Mo.	8½	8½	8½	8½	8½							
20	John Cleary, Chester, Ill.	*6	*6½	*7	*7½	*8							
21	St. Louis Bolt, Bridge and Forge Works, St. Louis, Mo.												2.55 100
22	H. L. Fox & Co., St. Louis, Mo.									3.15 100	2.62 100	2.65 100	*2.35 100

* Contracts awarded.

† Slight informalities in proposals.

‡ Quarry at Grafton, Ill.

|| Quarry at St. Louis, Mo.

NOTE.—Formal written contracts entered into with all successful bidders, except M. M. Buck & Co. for nails.

Abstract of proposals received in response to advertisement dated November 20, 1890, for constructing an extension to dam at Alton, Ill., opened December 20, 1890, by Maj. A. M. Miller, Corps of Engineers, St. Louis, Mo.

No.	Name and address of bidder.	Piles, 80 sticks, 3,200 feet.		Brush, 33,000 cubic yards.		Stone, 16,500 cubic yards.		Amount of each proposal.
		Price driven to 14 feet depth, per foot.	Amount.	Price driven beyond 14 feet depth, per foot.	Per cubic yard.	Amount.	Per cubic yard.	Amount.
1	James Short and John Gray, St. Charles, Mo.	\$0.28	\$896	\$0.35	\$0.50	\$16,500	\$1.40	\$23,100
2	A. J. Whitney, Rock Island, Ill.	0.20	640	0.05	0.65	21,450	1.30	21,450
3	H. S. Brown, Quincy, Ill.*	0.10	230	0.05	0.65	21,450	1.00	16,500

* Contract awarded.

Abstract of proposals received in response to advertisement dated January 24, 1891, for building and delivering at Bushberg, Mo., thirteen model barges, opened February 24, 1891, by Maj. A. M. Miller, Corps of Engineers, St. Louis, Mo.

No.	Name and address of bidder.	Number proposed to furnish.	Price each.
1	Sanford S. Holbrook, Cincinnati, Ohio *	6	\$3,750
2	Samuel W. Coffin, Cincinnati, Ohio †	13	3,795
3	St. Louis Sectional Dock Company, St. Louis, Mo.	4	4,600
4	James Hill, Madison, Ind.	13	4,150
5	J. J. Hammer & Son, St. Louis, Mo.	5	4,880

* Contract awarded for 6.

† Contract awarded for 7.

REPORT OF MR. D. M. CURRIE, ASSISTANT ENGINEER.

St. Louis, Mo., June 30, 1891.

MAJOR: I have the honor to submit the following report upon works for the improvement of Mississippi River, between the Illinois and Ohio rivers, including as part of it the reports of assistants in local charge, for the fiscal year ending June 30, 1891.

RUSH TOWER.

Work was begun at this locality about the middle of June, but on account of the excessive depths of water found near shore at the prevailing high stages of the river, but little progress had been made at the close of the fiscal year. Two hurdles, located as shown on the accompanying sketch, were started, and about 600 linear feet of mattress was placed in the protection of their shore ends, and a few piles were driven followed by the usual foundation mattress in each of the hurdles.

Reference is made to the report of Mr. C. D. Lamb for further details.

STE. GENEVIEVE.

This work embraced a series of hurdles below the foot of Turkey Island, located as shown on the accompanying tracing.

The bar below Turkey Island had extended down so far that Hurdle No. 1 of the project could not be built, when work was commenced in May, with the river at the stage of 14 feet above low water. Nos. 2, 3, and 4 were started in the order named and at the close of the year Nos. 2 and 3 were nearly finished and work was well advanced on No. 4.

Reference is made to the accompanying report of Mr. W. S. Mitchell for further details.

2094 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

PROCURING MATERIAL.

Brush was procured by hired labor, the details of which are shown in the accompanying report of Mr. C. D. Lamb, superintendent in local charge.

Piles were procured by contract delivered at the work.

Stone for riprap was procured by contract delivered on Government barges at Grafton, Ill.

Bolts, nails, rope, spikes, wire, and other miscellaneous material were procured by contract when the quantities required were large, and by purchase when small, delivered at the supply depot in this city.

The towboat, pile drivers, barges, and other plant used in connection with the work are public property. The repairs and additions to it will be summarized under the head of plant.

PLANT.

The barges, pile-drivers, and nearly all the other plant received extensive repairs in which 19 barges and 15 pile-drivers were taken out on the ways at Mound City, Ill., and repaired below light-water line. The other repairs and renewals needed to restore the efficiency of the plant were made by hired labor and purchase of material, the details of which are shown in the accompanying report of Mr. S. S. Van Norman, superintendent of supplies.

At the close of the year 13 model barges were under process of construction by contract.

Very respectfully, your obedient servant,

D. M. CURRIE,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. C. D. LAMB, SUPERINTENDENT.

St. Louis, Mo., June 30, 1891.

MAJOR: I have the honor to submit the following report of operations at Rush Tower during the fiscal year ending June 30, 1891:

The work to be done at Rush Tower includes the protection of the bank opposite "Kennett's" to prevent any further increase in the width of the chute east of the towhead and the beginning of hurdles, which form a part of the general project for improving this part of the river.

The construction of a shore mattress was begun on the 17th of June and at the close of the month 650 linear feet had been built and 575 linear feet placed, 75 linear feet being carried away by the strong current while partly sunk. This mattress was 80 feet wide, woven on way flat, and placed in three sections. It covered the bank from a 10-foot stage out to where the slope of the bank was very slight and has prevented all except a little surface scour.

The drift row of Hurdle No. 1, located 75 feet below the head of the shore mattress, was extended to a distance of 100 feet from shore, where the water was so deep that the piles on hand could not be used for the extension. A second hurdle was begun June 27, 900 feet below No. 1, and at the close of the year the drift row had been extended to a length of 100 feet.

The following table shows the amount of work done during the year, while its location is shown on the tracing accompanying the monthly report for June, 1891:

	Hurdle No. 1.	Hurdle No. 2.	Total.
Piles driven.....	19	15	34
Braces placed.....	11	11	22
Stringers placed.....	3	4	7
Shore mattress built:			
Linear feet.....			650
Square feet.....			52,000
Shore mattress placed:			
Linear feet.....			575
Square feet.....			46,000

Very respectfully, your obedient servant,

C. D. LAMB,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. W. S. MITCHELL, SUPERINTENDENT.

ST. LOUIS, MO., *June 30, 1891.*

MAJOR: I have the honor to submit the following report on the progress of the work for improving the Mississippi River at Ste. Genevieve, Mo., during the fiscal year ending June 30, 1891:

The project for this improvement of the river embraced a series of hurdles extending downstream from Turkey Island, and of such length as to reduce the width of the river to 2,500 feet next the Missouri shore. The upper hurdle was to be placed across the bar at the foot of the island, and the others were to follow at intervals of about 1,300 feet.

When work was begun, May 22, the stage of water, which was about 14 feet on the St. Louis gauge, did not admit driving piles on the upper line, Hurdle No. 1, within 750 feet from shore, and the bars extended so far below this line that Hurdle No. 2 seemed the upstream limit for the work, and here, also, a dry bar about 300 feet wide crossed the line 200 feet from shore, leaving a gap in the hurdle to be closed at higher water.

Pile-driving and mattress work were begun on both sides of this bar and were completed June 9. A rise of 7 feet in the 5 days preceding this date enabled the drivers to establish the line of drift piles across this gap, and the mattress was just started June 11, when the drift which had collected against the line and the rapid scour in the bottom carried out the piling. The drivers were put back in position and the line again started over the bar, but the few piles driven during the day were carried out at night. As the action of the jet-pump seemed to increase the scour and depths at the incomplete hurdle ends on either side of this gap it was thought best to move up 100 feet into shoaler water with less current and build a hurdle in front of the gap, connecting its ends with the main line. This work was completed June 29. During the rise drift had collected against the hurdle for 20 feet in width from the offset to the end of the line, 800 feet. A mattress was built over this and the whole was sunk to the bottom, forming a good protection for the base of this portion of the hurdle. The shore end of this line was protected with the usual stone and mattress revetment and the outer end by a T-head mattress. This hurdle is 1,500 feet in length and is complete, with the exception of wattling in those portions unprotected by drift.

Hurdle No. 3 was begun June 2 and was completed on the 29th. It is 1,350 feet long, and located 1,250 feet below No. 2, parallel and similar to the latter, with outer T-head mattress and revetted shore end. During its construction a portion of the drift row of piles about 250 feet from shore was crushed down against the hurdle row (the cross braces had not then been placed) by drift, piling, and a pile driver, which were carried out from No. 2 on June 11. The hurdle was not broken though, and after making a new drift row of the first hurdle row a new line of piles for wattling was driven behind it and protected by additional mattress. This hurdle is also complete with the exception of wattling.

Hurdle No. 4 was begun June 4, but on account of the rapid rise in the river and a scarcity of piles long enough for the work the drivers were withdrawn on the 6th and the line was not resumed until the 22d. None of the piling first placed was lost, and at the close of the month the drift row had been carried out 900 feet to the end of the line, and the mattress had been constructed 650 feet and sunk for 500 feet. This hurdle is parallel to the others and 1,400 feet below No. 3, and for 300 feet near shore crossed water, 30 to 35 feet in depth.

The season has been very favorable for the work, the river not having been at any time higher than 23 feet on the St. Louis gauge. The current at this stage has been very strong, but has brought with it a considerable deposit about the upper two hurdles.

The locations of the hurdles and soundings are shown on the chart accompanying the monthly report for June.

The force engaged on the work has averaged 10 pile drivers and 275 men, although it has been difficult to keep the full complement of men, owing to the demand for laborers in the country adjacent.

Very respectfully, your obedient servant,

WM. S. MITCHELL,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

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REPORT OF MR. C. D. LAMB, SUPERINTENDENT.

ST. LOUIS, MO., *June 30, 1891.*

MAJOR: I have the honor to submit the following report for procuring brush during the fiscal year ending June 30, 1891.

No brush was procured during the fall season, but work was begun with a small force February 25 at East Carondelet. Most of the brush procured at that locality was hauled across the Prairie du Pont Creek on a ponton bridge made of flats.

The following table shows the places at which brush was procured during the season, with length of time spent at each place, and the number of cords procured:

Locality.	Date of work.	Cords procured.
East Carondelet.....	Feb. 25 to Mar. 30	1,452.2
Arsenal Island.....	Mar. 31 to Apr. 8	767.0
Head of Wilson Island Bend.....	Apr. 9 to Apr. 20	1,283.9
South bank Missouri River, at mouth.....	Apr. 21 to May 19	3,550.9
Cora Point.....	May 20 to June 2	1,178.1
Brickhouse Bend.....	June 3 to June 9	252.0
Illinois shore at head Calico Island.....	June 10 to June 19	565.8
Durfee Point.....	June 20 to June 30	785.2
Total.....		9,744.1

The brush procured in February was loaded in the ordinary way, but about the 1st of March a pile driver was equipped with a derrick, which was used in loading the brush during the remainder of the season.

The brush was lifted from the wagons by the derrick and swung upon the barge, which was laid outside the driver and shifted as required. One man was required on the bank to fasten the load lines, 2 on the driver to handle the lines at the spools, and 3 on the barge to swing the load and place it in position. As at first arranged, with a short mast and 35-foot boom, about 10 cords per hour could be handled, but many changes were made during the season, and as now used 25 cords per hour can be loaded by 8 laborers and a steam engineer, a rate which would require about 35 laborers loading by hand, while the brush can be laid straighter and more compactly and unloaded with less labor.

Very respectfully, your obedient servant,

C. D. LAMB,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. S. S. VAN NORMAN, SUPERINTENDENT.

ST. LOUIS, MO., *June 30, 1891.*

MAJOR: I have the honor to submit my report of operations at the engineer supply depot connected with works of improvement under your charge for the fiscal year ending June 30, 1891.

Following is a general account of work done on each class of plant:

Tow boats.—Repairs to the steamer *General Gillmore* consisted of renewal of after-pilow block chain braces; roof, nosing, facing, and scroll work of pilot house; 10 feet of boiler deck rail; circle braces, keys, arms, and buckets of wheel; 146 feet plank-sheer, 106 feet nosing, 14 outriggers, most of the decking on the starboard guard, 4 kevels, and 4 fenders.

The guard rail, cabin roof, and boiler deck were patched and new glass placed in the cabin doors and skylights as needed.

The outriggers of both guards were calked at the ports, the interior of the cabin and rooms painted, the doors overhauled, new transom sash placed in the engine room and a new stage built.

Launches.—Two stern-wheel steam launches, or flats, of the following description were built during the year:

Length over all, 49 feet 11 inches; width, 10 feet 6 inches; depth amidship, 26 inches; diameter of wheel, 6½ feet; length of bucket, 7½ feet; width of bucket, 14 inches.

A cabin 6 feet high, 35 feet long, extending from the stern forward and terminating in a circular pilot house, was built on each launch.

Two slide-valve engines, 4 inches in diameter by 36-inch stroke, an "Economic" boiler and a "Hooker No. 4" steam plunger pump for supplying the boiler were provided each boat, besides a "Challenge" pump for general use.

Pile drivers.—Nos. 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 18, 19, and 20 were hauled out on the ways at Mound City, Ill., and repaired below the water line, the work done being principally as follows:

At the leads ends the knees, corner posts, plank-sheer, gunwales, and beams under ends of decking were renewed; the lower gunwale strakes and oak shoes at rake ends renewed or repaired, as required, the pump strainers overhauled, and the bottoms patched, calked, and pitched.

The following additional repairs were made at the supply depot:

New leads were placed on Nos. 7, 10, 12, 15, and 16, and one new lead each on Nos. 6 and 18.

One side brace was renewed on Nos. 5, 6, 7, 8, 11, 13, and 20; one ladder brace on Nos. 5 and 7; one ladder leg on No. 8; two on No. 13, and a crab frame on No. 15.

New beams and sills were placed under the boilers and pumps where necessary; the decks renewed or patched; the cabins, crab frames, ladders, platforms, chocks and all fastenings overhauled and repaired, cabins relettered and numbered, the holds cleaned, and all the drivers painted.

New hulls for No. 1, 3, 4, 15, and 17 were built, to which the cabins, machinery, etc., of the old hulls were transferred.

The new hull for No. 15 was made necessary by injuries sustained in a collision after the old hull had been repaired.

The hulls of Nos. 1, 3, 4, and 17 were worn out.

The machinery of all the drivers was placed in thorough repair and a well for supplying the main pumps put in each.

Barges.—Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 17, 18, 19, 21, 22, 24, 28, 29, and 30 were hauled out on the ways at Mound City, Ill., and repaired below the light water line as follows:

Renewed or repaired stems, and bottom and side planking. The oakum in the seams and butts of the bottoms and knuckles was reefed out, refilled, horsed up, and one thread of oakum made in on top of horsing, seams filled with tarred rope, and payed off with red lead and oil.

Repairs to most of the barges at the supply depot were extensive and of the following character:

On Nos. 1, 2, 3, 4, 5, 6, 7, 8, 11, 28, and 29 the decks, plank-sheer, center strakes, capstan beds, kevels, bits, chocks, hatch frames and covers, nosing, 189 beams, 94 stanchions under beams, 6,323 feet of side planking, 172 feet main clamp strake, 5 hood ends, and 17 top timbers were renewed; 17 floor timbers spliced; top and floor binding strakes repaired; 36 engraven pieces put in sides; gas-pipe pumps supplied, holds cleaned, and barges painted.

Repairs to Nos. 25, 26, and 27 were confined to patching decks and sides, renewing hatch covers, filling the plank-sheer, center strake, and large seams of sides with pine strips, substituting gas pipe for wooden pumps, calking, cleaning holds, and painting.

Quarter boats.—On Nos. 17, 18, 19, and 22 the fastenings of kevels, bits, and timberheads were overhauled, stove-pipe flanges renewed, the sides calked to 3 feet above the light water line, the decks at the ends of No. 19 and outside of quarters on No. 17 sheathed, and quarters and hulls painted.

The deck outside of quarters on No. 21 was sheathed, inside of quarters whitewashed, the deck of No. 16 patched, and fastenings of both overhauled.

Portable buildings, of 64 sections each, were put up on barges Nos. 25 and 27, the exterior of quarters painted and interior whitewashed.

Machine shop.—The hull of the machine shop having become unfit for service, the machinery was stored at the depot awaiting a new hull, for which provision has been made.

Small boats.—Twenty flats, 10 feet by 30 feet, were built, 10 of which were decked; 21 sets of ways erected on flats; 118 flats repaired by patching bottoms, sides, and decks, renewing timberheads, and calking.

Twelve new skiffs were purchased, and 51 skiffs and 19 yawls repaired and painted.

Tools and appliances.—Fifteen cant hooks, 102 cant-hook handles, 78 capstan bars, 16 gas pipe and 20 box pumps, 6 coal boxes, 37 pike poles, 6 grindstone frames, 14 wooden toggles, 39 signal poles, a boom 9 inches by 9 inches by 40 feet, a mast 10 inches by 10 inches by 8 feet, and a machinery truck, were made; a side dock built; 100 stage planks prepared, and 64 wheelbarrows, 14 tool boxes, and axes, augers, cant hooks, etc., repaired.

Portable buildings.—Besides the 13 sections reported under the head of "quarter boats" as having been placed on barges Nos. 25 and 27, new canvas was laid on the roofs of 9 sections at the supply depot, and 16 sections were taken down and stored.

Boarding outfit.—Twelve new water-cooler kegs were made ready for use and 7 old ones repaired.

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Two closets $6\frac{1}{2}$ feet by 4 feet, and one closet $3\frac{1}{2}$ feet by 4 feet, were made; 42 6 men bunks, 2 double and 1 single bunks put together; 6 tables and 14 benches reduced in length from 10 feet to 8 feet, and 2 ice boxes repaired.

Supply depot.—The office was raised, the sills, porches, gutters, and floor in one room renewed, the screen doors and windows repaired, and building painted.

The depot fence, coal and machinery sheds, and gutters to buildings were repaired, all the buildings painted and fence whitewashed.

Eight clumps of piles were driven in front of the depot for mooring purposes.

Water barrels were placed on the roofs of all the buildings, with means of ready access to them in case of fire.

All subsistence stores, as well as supplies of every description required in the field other than piles, brush, and stone, were also distributed from the depot.

Very respectfully, your obedient servant,

S. S. VAN NORMAN,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

Construction account, showing total cost of works to June 30, 1891.

Name of work.	Expended prior to July 1, 1890.	Expended during fiscal year ending June 30, 1891.	Total cost to June 30, 1891.
Piasa Island Dam	\$37,910.41		\$37,910.41
Piasa Island Dam, cutting channel	3,116.86		3,116.85
Alton Dam	33,740.05		33,740.05
Alton Dike	76,652.74	\$51.22	76,703.96
Sawyer Bend protection	96,803.63		96,803.63
Venice Dikes	36,341.85		36,341.85
St. Louis Harbor		99,729.86	99,729.86
Arsenal Island protection	42,599.06		42,599.06
Closing Cahokia Chute	119,958.21		119,958.21
Channel opposite St. Louis	58,455.54		58,455.54
Horsetail Bar, dikes 1 to 5, inclusive	225,066.31		225,066.31
Horsetail Bar, training wall	81,253.28		81,253.28
Horsetail Bar, hurdles	548,834.08		548,834.08
Horsetail Bar, bank protection	40,993.55		40,993.55
Carroll Island hurdle	4,093.58		4,093.58
Twin Hollows, west side, hurdles	248,837.82		248,837.82
Twin Hollows, west side, bank protection	31,370.55		31,370.55
Twin Hollows, east side, bank protection	128,920.30		128,920.30
Beards Island, primary hurdle	7,166.24		7,166.24
Beards Island, bank protection	84,258.76		84,258.76
Jim Smith's hurdles	365,803.33		365,803.33
Jim Smith's bank protection	7,569.58		7,569.58
Pulltight hurdles	340,778.57		340,778.57
Chesley Island, bank protection	64,416.04		64,416.04
Chesley Island hurdles	27,808.61		27,808.61
Sulphur Springs, hurdles	177,964.24		177,964.24
Lucas hurdles	128,056.65		128,056.65
Foster Island	44,296.02		44,296.02
Rush Tower		3,926.06	3,926.06
Fort Chartres Dam	36,812.86		36,812.86
Turkey Island	24,463.85		24,463.85
St. Genevieve		35,565.21	35,565.21
Kaskaskia protection	66,465.62		66,465.62
Liberty Island Dam	5,053.91		5,053.91
Liberty Island protection	45,129.40		45,129.40
Devil's Island Dike 1	65,871.17		65,871.17
Devil's Island, dams 1 and 2	66,526.88		66,526.88
Minton Point, hurdles	33,436.37		33,436.37
Cape Girardeau, primary hurdles	31,930.18		31,930.18
Cairo, protection	160,439.82		160,439.82
Total	3,599,195.92	139,272.35	3,738,468.27

Property and material account.

Class of property.	Balance July 1, 1890.	Debits.	Credits.	Balance June 30, 1891.
Barges, model.....	\$31,398.70	\$46,381.05	\$11,661.42	\$86,113.33
Steamer Gen. Gillmore.....	11,815.45	13,076.04	13,384.70	11,506.79
Pile drivers.....	20,969.83	28,665.25	3,693.75	45,941.33
Quarters.....	7,861.11	2,622.12	960.90	9,522.38
Tents.....	190.75			190.75
Supply depot.....	3,479.75	1,674.76	548.73	4,605.78
Machine shop.....	1,885.61	1,354.95	2,440.56	800.00
Small boats.....	6,643.70	11,129.87	1,713.25	16,060.32
Tools and appliances.....	1,626.00	3,795.71	457.06	4,964.65
Boarding outfit.....	9,306.97	1,635.11	950.66	9,991.42
Office furniture.....	428.48		42.85	385.63
Surveying instruments.....	471.61	32.25	47.16	456.70
Photographic apparatus.....	200.48			200.48
Subsistence.....	1,114.48	10,262.97	11,041.45	336.00
Brush.....		19,090.15	17,741.10	1,349.05
Piles.....	95.00	22,794.32	22,822.82	67.10
Stone.....	98.55	12,411.04	12,044.44	465.15
Rope.....	9,800.00	3,804.31	3,788.87	9,815.44
Wire.....	34.26	1,537.64	555.73	1,016.17
Iron.....	274.72	418.72	448.44	245.00
Nails.....	315.46	630.70	588.90	357.26
Spikes.....	131.72	1,301.43	765.87	667.28
Bolts.....	988.83	3,928.04	1,764.75	3,152.12
Lumber.....	485.15	14,025.03	13,829.89	680.29
Oakum.....	90.14	1,057.77	916.62	231.29
Coal.....	321.00	4,582.52	4,605.67	297.85
Ice.....		1,255.93	1,255.93	
Miscellaneous material.....	394.58	8,968.68	7,520.80	1,832.66
Launches.....		6,513.62		6,513.62
Quarter boats.....		15.00	15.00	
Total.....	110,417.93	222,954.98	135,607.12	197,765.79

Detail construction account, showing cost of works during fiscal year ending June 30, 1891.

Labor, material, plant, etc.	St. Genevieve.	Rush Tower.
Labor, superintendence, etc.....	\$11,165.80	\$1,432.00
U. S. Engineer Office.....	558.44	70.43
General expense.....	758.13	96.62
Telephone.....	180.37	22.75
Gauge readers.....	35.52	4.48
Steamer Gen. Gillmore.....	670.45	81.50
Quarter barges.....	437.12	66.41
Pile drivers.....	822.57	40.31
Quarters.....	163.56	44.03
Supply depot.....	113.55	15.32
Small boats.....	414.83	43.52
Tools and appliances.....	102.42	12.27
Boarding outfit.....	407.61	49.75
Survey instruments.....	7.39	1.00
Office furniture.....	8.88	1.12
Brush.....	4,185.16	679.00
Piles.....	5,789.65	142.09
Stone.....	2,907.93	252.84
Subsistence.....	4,291.07	521.18
Rope.....	577.20	72.15
Wire.....	128.59	25.00
Oakum.....	.73	3.65
Nails.....	59.67	13.26
Spikes.....	135.32	14.35
Screw bolts, etc.....	502.40	7.85
Lumber.....	67.20	82.00
Coal.....	316.73	36.84
Ice.....	556.21	87.74
Miscellaneous material.....	194.62	37.60
Total.....	35,565.21	3,926.06

2100 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

A.—Record of gauge at Grafton, Ill., for fiscal year ending June 30, 1891.

[Height of water above a plane 200 feet below St. Louis City Directrix.]

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	204.53	195.04	192.68	193.31	195.38	193.23	191.23	191.33	194.50	203.10	203.80	197.53
2	204.58	194.84	192.77	193.29	195.15	193.14	191.47	191.61	194.41	202.91	203.75	197.41
3	204.53	194.63	192.75	193.23	194.90	193.09	191.81	191.73	194.07	202.78	203.67	197.30
4	204.35	194.40	192.77	193.34	194.81	193.03	192.23	191.03	194.01	202.59	203.63	197.20
5	204.10	194.16	192.77	193.66	194.76	192.97	192.13	190.78	194.40	202.21	203.56	197.00
6	203.88	193.87	192.86	193.79	194.72	192.91	191.92	190.20	194.90	202.30	203.50	197.03
7	203.64	193.73	192.94	193.86	194.64	192.86	191.73	190.19	195.50	202.63	203.38	197.20
8	203.38	193.63	193.03	193.74	194.53	192.63	191.83	190.60	195.60	202.90	203.22	197.42
9	203.08	193.71	193.18	193.63	194.24	192.13	191.91	190.72	195.48	203.14	203.10	197.67
10	202.53	193.73	193.26	193.58	194.08	191.83	192.03	190.97	195.30	203.50	202.96	197.80
11	202.13	193.66	193.34	193.51	193.91	191.53	192.01	191.20	195.10	203.41	202.83	197.60
12	201.44	193.53	193.42	193.44	193.77	191.40	191.93	191.42	194.84	203.16	202.79	197.04
13	200.93	193.43	193.38	193.36	193.64	191.17	191.80	191.43	194.62	203.01	202.10	196.80
14	200.51	193.31	193.30	193.24	193.73	190.83	191.63	191.71	194.50	202.92	201.70	196.60
15	199.03	193.09	193.17	193.13	193.68	190.73	191.49	192.20	193.80	203.05	201.20	196.52
16	198.70	192.88	193.12	193.11	193.62	190.66	191.33	192.37	193.60	203.16	200.80	196.52
17	198.41	192.80	193.13	193.11	193.59	190.60	191.13	192.53	193.80	203.30	200.10	196.50
18	198.03	192.71	193.31	193.53	193.55	190.73	191.16	192.50	194.02	203.60	199.63	196.48
19	197.67	192.59	193.63	193.91	193.53	191.13	191.23	192.42	194.38	203.76	199.30	196.20
20	197.35	192.53	193.88	194.18	193.50	191.33	191.28	192.41	195.40	203.65	198.90	196.80
21	196.86	192.50	193.97	194.33	193.46	191.63	191.34	191.20	196.80	203.60	198.60	197.20
22	196.73	192.53	194.03	194.39	193.43	191.73	191.40	191.91	197.80	203.75	198.62	197.70
23	196.54	192.64	193.98	194.40	193.34	191.61	191.43	192.20	198.35	203.80	198.70	198.02
24	196.38	192.73	193.87	194.41	193.39	191.45	191.58	192.70	199.05	204.08	198.62	198.30
25	196.29	192.84	193.76	194.43	193.36	191.29	191.44	193.30	200.80	204.62	198.43	197.90
26	196.20	193.05	193.67	194.50	193.35	191.13	191.43	193.90	201.45	205.05	198.28	197.67
27	196.03	193.13	193.62	194.68	193.33	191.04	191.18	194.21	201.75	204.65	198.08	197.40
28	195.83	193.13	193.59	194.80	193.33	190.93	191.17	194.50	202.01	204.06	197.90	197.00
29	195.65	193.11	193.46	194.99	193.29	190.73	191.14	.....	202.66	203.90	197.80	196.50
30	195.54	192.98	193.37	195.26	193.23	190.74	191.16	.....	202.88	203.80	197.78	196.30
31	195.43	192.86	.....	195.38	.....	190.99	191.21	.....	203.05	.....	197.54	.....

Standard low water at St. Louis 170.19 feet.

A.—Record of gauge at Grays Point, Mo., for fiscal year ending June 30, 1891.

[Height of water above a plane 200 feet below St. Louis City Directrix.]

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1.....	108.26	99.76	94.91	96.66	94.81	94.06	92.46	93.66	106.21	109.36	103.86	103.81
2.....	108.16	99.86	94.91	96.66	94.96	95.76	92.61	93.76	106.11	109.66	103.31	103.56
3.....	107.96	99.01	94.76	96.76	96.91	95.46	93.31	93.96	104.91	110.06	103.76	103.06
4.....	108.46	98.76	94.66	96.86	96.86	95.26	93.81	94.36	104.71	110.06	103.86	102.36
5.....	107.66	98.56	94.66	96.76	96.76	95.06	94.36	94.86	104.36	109.81	103.96	102.26
6.....	107.46	98.26	94.36	96.66	96.61	95.01	94.66	95.16	104.26	109.56	103.06	104.36
7.....	107.26	98.06	94.46	96.46	96.41	94.81	94.61	95.41	103.81	109.36	103.61	103.36
8.....	107.16	97.96	94.46	96.36	96.21	94.76	94.41	96.26	103.46	109.16	103.06	103.56
9.....	106.91	97.86	94.46	96.26	96.11	94.66	94.51	96.61	103.21	109.06	107.66	107.96
10.....	106.81	97.71	97.76	96.16	96.06	94.81	94.81	96.81	103.11	108.46	107.21	109.56
11.....	106.51	97.66	97.06	96.06	95.86	94.81	94.86	97.16	102.91	108.26	106.56	110.61
12.....	105.96	97.56	96.96	96.26	95.76	93.51	94.81	97.51	102.76	108.96	106.06	110.76
13.....	105.41	97.31	97.36	96.66	95.61	93.41	94.76	97.81	102.51	109.06	105.71	110.56
14.....	104.66	97.01	97.26	96.56	95.41	93.16	94.46	98.06	102.36	109.56	105.56	110.06
15.....	104.01	97.01	96.96	96.36	95.31	93.06	94.26	98.41	102.36	109.46	105.06	108.06
16.....	103.96	96.96	96.56	96.06	95.36	92.71	93.86	99.11	102.16	108.96	104.66	107.56
17.....	103.86	97.41	96.11	95.66	95.61	92.46	93.61	99.21	102.16	108.96	104.26	107.31
18.....	103.41	97.86	96.06	95.41	95.76	92.26	93.26	99.21	102.06	110.26	103.86	107.41
19.....	102.96	97.36	95.96	95.51	95.76	92.21	93.01	99.46	102.01	110.96	103.41	107.26
20.....	102.06	96.86	95.81	96.11	95.76	92.21	92.96	100.01	101.96	111.06	102.91	106.96
21.....	101.66	96.76	95.96	96.66	95.86	92.26	92.96	102.06	101.86	111.16	102.26	106.86
22.....	101.36	96.86	96.26	97.76	95.96	92.31	93.11	101.86	102.31	111.06	101.86	106.96
23.....	101.16	96.56	96.61	97.76	96.41	92.46	93.26	102.01	102.96	110.91	101.31	107.56
24.....	101.36	97.01	96.86	97.66	97.16	92.06	93.26	103.01	103.81	110.76	101.51	108.26
25.....	101.21	97.41	96.86	97.56	97.56	92.81	93.41	103.71	105.11	111.06	101.96	109.41
26.....	101.31	97.56	96.86	97.41	97.46	92.96	93.46	104.21	106.36	111.26	102.16	110.18
27.....	101.46	97.76	96.76	97.26	97.16	92.96	93.41	104.91	107.06	111.06	102.96	109.91
28.....	101.36	97.46	96.56	97.11	97.86	93.06	93.31	105.16	107.46	110.56	103.81	109.06
29.....	100.86	97.41	96.56	96.91	96.66	92.96	93.26	.....	107.81	109.96	104.11	107.26
30.....	100.36	97.16	96.56	96.76	96.46	92.66	93.16	.....	108.46	109.26	103.71	107.31
31.....	99.96	96.96	.....	96.86	.....	92.36	93.46	.....	109.16	.....	103.71	.....

Standard low water at St. Louis 170.19 feet.

Depth of water, in feet, upon the

Date.	Stage above standard low water by St. Louis gauge.	Name of steamer furnishing report.	Direction.	Arsenal Island.	Quarantine.	Twin Hollows.	Pulltight.	Fines Bluff.	Meramec.	Sulphur Springs.	Lucas.	Forest Home.	Perry's Towhead.	Perry's Towhead (foot).	Salt Lake.
1890.	<i>Feet.</i>														
July 5	15.80	City of Monroe	Down.	10 $\frac{1}{2}$	6	1 $\frac{1}{2}$	10 $\frac{1}{2}$	16 $\frac{1}{2}$	8	12	10	12	8		
12	13.10	Sidney Dillon	do	15	12	9 $\frac{1}{2}$	16 $\frac{1}{2}$	10 $\frac{1}{2}$	15	12	10	12	12		
13	12.30	Arkansas City	do	15		12									
16	12.80	City of St. Louis	do	15	10 $\frac{1}{2}$				15	15	15	13 $\frac{1}{2}$	10 $\frac{1}{2}$		
16	12.80	City of Vicksburg	do			9 $\frac{1}{2}$									
17	11.20	John Gilmore	do	13 $\frac{1}{2}$	8	13 $\frac{1}{2}$	12	10 $\frac{1}{2}$	9 $\frac{1}{2}$	10 $\frac{1}{2}$	9 $\frac{1}{2}$	10 $\frac{1}{2}$	9 $\frac{1}{2}$		
20	9.30	City of Cairo	do		7 $\frac{1}{2}$			13 $\frac{1}{2}$							
22	8.80	City of Monroe	do	12	10	9			6 $\frac{1}{2}$						
23	8.70	Henry Lowrey	do	9	12	7 $\frac{1}{2}$	9 $\frac{1}{2}$	15	9	10 $\frac{1}{2}$	9	8	10 $\frac{1}{2}$		
23	8.70	Sidney Dillon	do	12	12	7 $\frac{1}{2}$	12	12	9 $\frac{1}{2}$	10 $\frac{1}{2}$	9	8	10 $\frac{1}{2}$		
24	8.70	City of Providence	do	12	12	7 $\frac{1}{2}$		12	12	9	9	9	10 $\frac{1}{2}$		
26	9.20	City of Hickman	do	13 $\frac{1}{2}$	8				12	12	10 $\frac{1}{2}$	10 $\frac{1}{2}$	10 $\frac{1}{2}$		
27	9.00	Jay Gould	do	9	10 $\frac{1}{2}$	8		12	16 $\frac{1}{2}$	9	9 $\frac{1}{2}$	9	10 $\frac{1}{2}$		
Aug. 7	5.30	City of Providence	do	8	9	5 $\frac{1}{2}$	10 $\frac{1}{2}$	12	9	10 $\frac{1}{2}$	6	6	9		
10	5.10	Sidney Dillon	do	10 $\frac{1}{2}$	9	5		9	10 $\frac{1}{2}$	6	8	6	8 $\frac{1}{2}$		
13	4.50	City of New Orleans	do	8 $\frac{1}{2}$	4 $\frac{1}{2}$		8 $\frac{1}{2}$	12	8	8	9	6	7		
14	4.40	Belle Memphis	do	9	9	5	7 $\frac{1}{2}$	12	8	8	5 $\frac{1}{2}$		9		
19	4.20	City of Monroe	do	9	5 $\frac{1}{2}$	10 $\frac{1}{2}$									
27	4.50	City of St. Louis	do	10 $\frac{1}{2}$	5 $\frac{1}{2}$		8		7	9	7		9		
28	4.40	City of Vicksburg	do	10 $\frac{1}{2}$	6										
Sept. 6	3.90	City of Hickman	do					10 $\frac{1}{2}$	8	6	6		9		
20	3.30	City of Hickman	do					10 $\frac{1}{2}$	8	8	8		9		
27	4.00	City of Cairo	do	8 $\frac{1}{2}$	2 $\frac{1}{2}$			8	7				9		
30	3.70	City of Monroe	do	9	6			9	8						
Oct. 8	3.40	City of St. Louis	do		7										
29	4.20	City of St. Louis	do		9	7		9	8						
Nov. 3	4.20	City of Hickman	do						10 $\frac{1}{2}$	9	6 $\frac{1}{2}$	6 $\frac{1}{2}$	6 $\frac{1}{2}$		
4	4.00	Arkansas City	do		8 $\frac{1}{2}$				9	8	6 $\frac{1}{2}$	6 $\frac{1}{2}$	6 $\frac{1}{2}$		
8	3.10	City of Monroe	do		6				7				7		
8	3.10	Jay Gould	do		5			8					6 $\frac{1}{2}$		
8	3.10	City of New Orleans	do	8		6			7	6 $\frac{1}{2}$			6 $\frac{1}{2}$		
14	2.30	City of Baton Rouge	do	6 $\frac{1}{2}$	6				7	6 $\frac{1}{2}$			7		
16	2.30	Sidney Dillon	do		7	5 $\frac{1}{2}$		6	8	6					
16	2.30	City of Vicksburg	do		5 $\frac{1}{2}$			7 $\frac{1}{2}$	7						
17	2.60	Belle Memphis	do	8	5 $\frac{1}{2}$				7						
19	2.60	City of St. Louis	do		7	5 $\frac{1}{2}$		8	8	8					
22	4.00	Arkansas City	do		6 $\frac{1}{2}$				8	8					
24	4.90	Gen. Gillmore	do	10 $\frac{1}{2}$	8 $\frac{1}{2}$	8	18	9	8	9	8				
28	3.70	City of New Orleans	do					8	7	7					
Dec. 3	2.10	City of Baton Rouge	do		6 $\frac{1}{2}$			7	7	7			6		
3	2.10	Sidney Dillon	do	8	6	5 $\frac{1}{2}$		7	6 $\frac{1}{2}$	6 $\frac{1}{2}$			7		
6	1.90	City of Hickman	do		8			6 $\frac{1}{2}$	7	6 $\frac{1}{2}$					
12	.40	Sidney Dillon	do	7	5 $\frac{1}{2}$	7 $\frac{1}{2}$		5 $\frac{1}{2}$	6 $\frac{1}{2}$	5 $\frac{1}{2}$			4 $\frac{1}{2}$	5 $\frac{1}{2}$	
1891.															
Jan. 8	1.10	My Choice	do	9	6	7 $\frac{1}{2}$		6 $\frac{1}{2}$	6	6	8	5 $\frac{1}{2}$	7	7	
23	— .20	Sidney Dillon	do	7	6	7 $\frac{1}{2}$		6 $\frac{1}{2}$	6	6	6	5 $\frac{1}{2}$	7	7	
27	— .20	do	do	5 $\frac{1}{2}$	7		8	7	7	6	6 $\frac{1}{2}$	6	7	7	
Feb. 6	.70	do	do		6	7		7	8	5	6	6	8		
9	— .50	Arkansas City	do	7 $\frac{1}{2}$				8	8	6 $\frac{1}{2}$	5 $\frac{1}{2}$				
12	— .40	City of Hickman	do			8	6	7 $\frac{1}{2}$	8	7 $\frac{1}{2}$					
Mar. 12	3.80	Gen. Gillmore	do	10 $\frac{1}{2}$	9	9 $\frac{1}{2}$									
18	2.90	do	do	9 $\frac{1}{2}$	8 $\frac{1}{2}$	8									
26	13.00	do	do	16 $\frac{1}{2}$											
May 21	9.40	do	do	12	10	9 $\frac{1}{2}$		13 $\frac{1}{2}$		12	9 $\frac{1}{2}$				
June 4	10.10	do	do	13 $\frac{1}{2}$	12	12	9	12	13 $\frac{1}{2}$	13 $\frac{1}{2}$					
10	18.60	do	do	19 $\frac{1}{2}$		19 $\frac{1}{2}$	13 $\frac{1}{2}$	18		18					

bars between St. Louis and Cairo.

Salt Point.	Fort Chartres.	Crookes.	Cambria Hollow.	Mudds Landing.	St. Genevieve Island.	St. Genevieve Bend.	St. Marys River.	Blocks.	Manscoes.	Liberty Island.	'76 Landing.	Tower Island.	Crawfords.	Neely Landing.	Vancil Landing.	Willards.	Bainbridge.	Shinemans.	Kinney Point.	Belle Golden.	Devils Island.	Jacket Pattern.	Goose Island.	Hacker Bend.	Buffalo Island.	Thompson.	Brewers Point.	Greenleaf.	Greenfield.
9 ¹	13 ¹	12	6	12	10 ¹	12	12	9	16	12	18	7	7	7 ¹	9	16 ¹	16	15	15	6	12	12	6	8	12	16	16	13	...
13 ¹	12	12	...	13 ¹	13 ¹	13 ¹	13 ¹	15	12	15	12	12	12	12	12	12	12	15	13 ¹	13 ¹	10 ¹	10 ¹	12	12	16 ¹	12	12	...	
9	...	9	...	13 ¹	10 ¹	12	9 ¹	12	12	12	12	12	10 ¹	12	12	12	...	13 ¹	13 ¹	8	8	10 ¹	10 ¹	10 ¹	15	12	9 ¹	...	
8	...	8	...	10 ¹	10 ¹	15	10 ¹	9	12	12	10 ¹	9	9	9	10 ¹	9 ¹	12	10 ¹	10 ¹	6	10 ¹	10 ¹	8	9	12	9 ¹	7	...	
9	...	9	...	10 ¹	10 ¹	15	10 ¹	10 ¹	9	10 ¹	10 ¹	10 ¹	9	9	10 ¹	9	12	10 ¹	10 ¹	7	10 ¹	10 ¹	8	9	12	9 ¹	8	...	
6 ¹	7 ¹	8	...	9	7	7	7	6 ¹	8	6 ¹	10 ¹	8	9	8	8	9	8	9	9	10 ¹	5	5	8	5	9	9	9	10 ¹	...
6 ¹	7 ¹	8	...	8	9	7	7	7 ¹	8	8	10 ¹	8	9	8	8	9	9	12	10 ¹	10 ¹	6	6	8	8	8	8	8	10 ¹	...
6 ¹	7	7	...	7	7	8	8	8	8	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	8	6 ¹	6 ¹	5	6	6	6	6	6	6	6	10 ¹	...
7	6	...	...	...	...	7	7	9	8	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10 ¹	...
6	7	7	...	7	7	7	7	7	7	6 ¹	6 ¹	6 ¹	7	6 ¹	7	7	7	7	7	6	6	6	6	6	6	6	6	10<	

2104 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

COMMERCIAL STATISTICS.

Receipts and shipments at St. Louis, Mo., during the years 1888, 1889, and 1890.

Articles.	Receipts.			Shipments.		
	1888.	1889.	1890.	1888.	1889.	1890.
Barbed wire and ores and metals (pig and manufactured)	<i>Tons.</i> 32,738	<i>Tons.</i> 31,063	<i>Tons.</i> 21,782	<i>Tons.</i> 6,748	<i>Tons.</i> 5,885	<i>Tons.</i> 3,945
Cement	5,344	6,876	15,892			
Coal and coke	96,208	88,845	81,565	7,605	1,701	734
Cotton (and products)	5,178	4,663	4,230	23	200	527
Groceries and dairy products	7,911	8,815	8,262	7,598	8,047	7,428
Hay, seeds, and grains, including flour, meals, etc.	100,384	96,265	92,914	342,200	538,329	440,728
Jute	2,724	3,473	235			
Live stock and products	12,821	12,805	17,347	14,619	15,429	18,379
Lumber	130,855	127,095	132,940	13,085	6,470	8,526
Merchandise and sundries	325,548	281,579	284,589	112,904	131,546	117,806
Vegetables	8,062	7,986	3,530	2,260	2,612	1,739
White lead, oils, etc.	670	756	204	2,265	1,799	1,379
Wines and liquors	174	102	60	772	647	663
Wool	193	162	180	36	35	3
Total	728,810	671,685	663,730	510,115	712,700	601,682

Transferred by ferries across the river at St. Louis.

	<i>Tons.</i>
1888	2,351,681
1889	2,717,760
1890	3,052,166

Shipments down the river from landings between St. Louis and Cairo during the years 1888, 1889, 1890.

	<i>Tons.</i>
Grain, including flour, meals, etc.:	
1888	87,257
1889	29,209
1890	34,267

RECAPITULATION.

	1888.	1889.	1890.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Receipts and shipments at St. Louis	1,238,925	1,384,385	1,265,592
Transferred by ferries at St. Louis	2,351,881	2,717,760	3,052,166
Shipped from landings between St. Louis and Cairo	37,257	29,209	34,267
Total	3,628,063	4,131,354	4,352,025

NOTE.—Increase of 220,671 tons for year 1890 over year 1889.

Arrivals and departures of steamboats and barges at St. Louis during the years 1888, 1889, 1890.

	Arrivals.			Departures.		
	1888.	1889.	1890.	1888.	1889.	1890.
Steamboats	2,079	2,195	1,927	2,076	2,211	1,910
Barges	1,244	1,474	1,274			

List of steam-power boats that arrived at St. Louis during the year 1890.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	
Abner O'Neal.....	150	23.4	3.8	197.74
Alice Blair.....	180	25	4	119.98
Alice Brown.....	198	34	4	551.36
Arkansas City.....	273.7	44.7	7.8	1,296.99
A. L. Mason.....	252	52.6	6	1,130.84
A. Saltzman.....	75	16	3	36.00
Albert S. Willis.....	153.1	26.5	3.6	132.99
Bald Eagle.....	202.3	30	5.4	454.71
Bart E. Linehan.....	127	23.5	3.9	173.82
Belle Memphis.....	267	42.7	7.6	1,222.89
Benton.....	197	23	5	394.08
Ben. Wood.....	223	23	5	143.69
Brother Jonathan.....	110.6	21	4	116.23
Calhoun.....	230	36	5.4	631.74
Carrie.....	75	13	2	29.62
Charlotte Boeckeler.....	140	29.4	4.1	143.48
Charley McDonald.....	147	30	4.5	259.52
Cherokee.....	216.4	33.9	5.4	631.20
City of Alma.....	110	20	4	95.07
City of Baton Rouge.....	290	48	8.7	1,603.96
City of Cairo.....	271.2	44	7.8	1,296.12
City of Florence.....	190	32	5.3	358.81
City of Hickman.....	235	44.5	9.5	1,555.17
City of Monroe.....	275	45	8	1,038.25
City of New Orleans.....	290	48	8.5	1,536.28
City of Providence.....	273.1	44.5	7.8	1,308.81
City of St. Louis.....	300	49	8.8	1,614.02
City of Savannah.....	196	31.2	5.3	335.55
City of Sheffield.....	183	35	5.5	329.74
City of Vicksburg.....	273.7	44.5	8.2	1,364.52
Clyde.....	125	19	4	144.00
Commodore.....	97	23.2	3.2	86.45
C. R. Suter.....	189.6	52	7	(*)
Crystal City.....	234	42.2	7	523.28
D. H. Pike.....	199.6	33.5	5.5	465.75
Dick Clyde.....	95.8	17.4	3.9	76.84
Dolphin.....	135.8	22.8	4.8	156.16
Dora.....	199.5	25.2	4.8	392.23
Duran.....	(*)	(*)	(*)	(*)
Eagle.....	155.6	24.8	4.3	231.30
Ed. Durant, jr.....	(*)	(*)	(*)	(*)
Edith.....	101	24	3.1	69.59
Edna.....	102	21.5	4.7	80.35
E. M. Norton.....	174	30	6	549.53
Ferd. Herold.....	244.6	34	7.2	900.58
Future City.....	187.4	36	6.1	589.30
Gem City.....	263	29.8	5.6	580.56
General Barnard.....	215	37	5	500.00
General Gillmore.....	140	28	4	125.00
General H. F. Devol.....	130	22.5	3.8	156.99
Geo. Lyale.....	174	33	6	426.74
Golden Gate.....	181.4	30	4	142.17
Grand Republic.....	260	50	8.5	1,985.92
Harry Clyde.....	(*)	(*)	(*)	(*)
Helena.....	194	33	4.5	352.31
Henry Lourey.....	209.6	35.2	5.3	643.79
H. F. Friable.....	169.4	32.2	5.8	270.45
H. G. Wright.....	190	62	8	(*)
Hiawatha.....	(*)	(*)	(*)	(*)
H. M. Hoxie.....	213.2	34.3	5.6	622.30
Helene Schultenberg.....	130.3	25.4	3.7	107.95
Idlewild.....	207.6	35.6	5.7	520.36
Imperial.....	89.3	19	4.8	68.08
Irene D.....	133	24.3	(*)	142.76
Iron Age.....	176	38	5.5	385.91
Iron Duke.....	177	32.6	6	421.25
Ironsides.....	154	30	6.4	282.80
Jack Frost.....	165	30	5.4	350.77
Jay Gould.....	186.8	30.4	6	446.35
John Gillmore.....	183	34	6	503.09
John L. Ferguson.....	111.6	25.6	13.6	79.31
John N. Maccomb.....	176.9	62	7	(*)
Joseph Walton.....	158	27	5	360.37
Josie.....	143	28	5	237.51
Julia.....	107	22	3.5	58.51
Kit Carson.....	188.6	29.2	4	237.09
Libbie Conger.....	168	29.5	4.5	324.00
Lily.....	178	28	4.3	200.00
Little Eagle No. 2.....	130.7	19.2	3.9	82.65
Lizzie Gardner.....	124.5	21	3.6	70.54
Longfellow.....	112	19.6	4.3	98.59
Lottie.....	55	16	2.3	13.64

* Not known.

2106 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

List of steam-power boats that arrived at St. Louis during the year 1890—Continued.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	
Louis Hauck	210	37	6	913.27
Maggie Reaney	128.5	25	4.5	148.62
Mary M. Michael	143.3	26.3	4.4	234.34
Mary Morton	210	32.5	6	456.96
Mississippi	175	32.5	6	390.14
Musser	137	24	4.6	163.63
My Choice	183	35	5	462.23
Nellie Speer	145.4	27	5	224.10
New Idea	(*)	(*)	(*)	(*)
Niagara	98	17.6	7.2	99.41
Oakland	210	35	6	628.81
Oliver Bieme	265	43.6	7	1,017.78
Parker	65	16.4	7.2	47.45
Pearl	228.2	23.5	4.1	149.95
Pittsburg	250	39.2	5.8	722.17
Polar Wave	146	25.7	5	150.34
Port Eads	197.8	33.3	6	334.38
Racket	90.1	16.2	3.6	55.62
R. A. Speed	124	22	4.2	210.13
Reliance	126	21.5	4.2	70.31
Saint Paul	300	36.3	6.2	833.53
Sam. Clarke	(*)	(*)	(*)	(*)
Satellite	76.5	15.9	3.9	53.55
Scotia	(*)	(*)	(*)	(*)
Sidney	221.3	35.5	3.5	617.88
Sidney Dillon	175	33.8	5.5	420.68
S. L. Wood	(*)	(*)	(*)	(*)
Spread Eagle	224.5	33.8	5.7	529.34
Stattie Fisher	122	28	4	106.52
State of Kansas	252	52.6	6	1,130.34
T. F. Eckert	176	34.5	5	510.43
Thistle	150	28.5	4.8	403.45
Viola Parker	52.5	11.2	4.9	16.09
War Eagle	279.2	42	6.1	953.74
Whale	96.5	13.4	8.1	88.96
W. H. Cherry	169	32	5.2	396.07
White Eagle	238	29	3.8	312.75
William Stone	136.2	26	4.9	174.00
W. P. Bishop	93.9	16.5	2.5	69.09

List of barges that arrived at St. Louis during the year 1890.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	
Adelaide	154.4	28.0	5.0	196.24
Allegheny	(*)	(*)	(*)	(*)
Anchor Line No. 1	167.5	32.6	7.5	634.82
Anchor Line No. 2	167.5	32.8	7.5	692.19
Annie	130.6	19.3	5.6	101.64
Annie Spies	(*)	(*)	(*)	(*)
Beam	(*)	(*)	(*)	(*)
Buckeye	(*)	(*)	(*)	(*)
Cape Girardeau Transportation Company, No. 1 to 21	(*)	(*)	(*)	(*)
Centennial	(*)	(*)	(*)	(*)
Chester	186.4	34.6	7.0	885.09
Chicago Belle	(*)	(*)	(*)	(*)
Chunk	(*)	(*)	(*)	(*)
Continental	(*)	(*)	(*)	(*)
Daisy	(*)	(*)	(*)	(*)
Dean Adams	(*)	(*)	(*)	(*)
Dickey	(*)	(*)	(*)	(*)
Dolomite	154.4	26.8	5.0	172.49
Eagle	(*)	(*)	(*)	(*)
Fannie	153.4	27.9	5.0	181.08
Garry	(*)	(*)	(*)	(*)
Griffith and Adams, Nos. 12, 14 to 17	(*)	(*)	(*)	(*)
Helena	186.4	34.6	7.0	862.16
Homestead	(*)	(*)	(*)	(*)
Irondale	(*)	(*)	(*)	(*)
Jessie	152.4	27.4	5.4	188.72
J. M. Norton	(*)	(*)	(*)	(*)
John Bailey	(*)	(*)	(*)	(*)
John N. Dravo	(*)	(*)	(*)	(*)
J. N. Williamson	(*)	(*)	(*)	(*)
Josie	152.4	27.6	5.4	197.78
Josie	(*)	(*)	(*)	(*)
Kennebec	(*)	(*)	(*)	(*)

* Not known.

List of barges that arrived at St. Louis during the year 1890—Continued.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	
Keokuk No. 1	140.6	20.4	3.5	88.58
Lella	154.0	27.9	5.0	182.02
Lusk	(*)	(*)	(*)	(*)
Mack	(*)	(*)	(*)	(*)
Martin Michael	146.0	24.2	4.2	118.07
Metropolis	(*)	(*)	(*)	(*)
Midland	(*)	(*)	(*)	(*)
Missouri Sand Company, Nos. 1 to 4	(*)	(*)	(*)	(*)
Monongahela	(*)	(*)	(*)	(*)
Morton	(*)	(*)	(*)	(*)
Mose	152.0	26.4	4.6	153.56
Nellie Peck	(*)	(*)	(*)	(*)
New St. Louis Sand Company, No. 7	(*)	(*)	(*)	(*)
Occident	(*)	(*)	(*)	(*)
Ostrich	(*)	(*)	(*)	(*)
Pike, No. 2	171.6	27.2	5.2	188.79
Rachel	189.6	34.8	6.4	639.50
R. A. Speed, Nos. 2 to 4	(*)	(*)	(*)	(*)
Rover, Nos. 1	165.0	28.0	6.0	474.62
2	165.0	28.0	6.0	215.74
3	137.8	28.0	5.2	158.22
4	138.2	28.2	5.2	156.77
Ruth	179.2	34.7	6.6	759.66
Spread Eagle	(*)	(*)	(*)	(*)
Sterling	(*)	(*)	(*)	(*)
Swan	(*)	(*)	(*)	(*)
St. James	152.0	27.0	5.4	28.64
St. Louis and Mississippi Packet Company, Nos. 2, 7	(*)	(*)	(*)	194.81
St. Louis and Mississippi Valley Transportation Company:				
No. 19	211.5	40.6	7.5	1,349.65
20	201.2	35.6	8.0	1,011.18
21	200.6	36.0	7.8	1,002.40
22	200.5	36.0	7.8	1,015.91
23	200.0	36.0	8.0	986.62
24	200.5	35.2	7.3	1,018.84
25	201.4	35.6	7.2	1,020.60
26	203.5	36.0	7.6	1,060.79
27	200.5	35.6	7.4	1,038.47
29	201.0	35.6	7.6	1,021.19
30	225.6	34.8	8.0	1,126.85
32	224.6	34.8	8.2	1,130.69
33	227.0	35.0	8.8	1,171.99
34	225.6	34.8	8.0	1,135.15
35	225.6	34.8	8.0	1,129.63
36	225.6	34.8	8.2	1,166.34
37	227.0	35.0	8.4	1,193.11
38	229.0	36.5	8.8	1,197.31
39	230.0	36.7	8.3	1,201.29
40	226.0	36.6	8.0	1,110.48
41	226.0	36.4	8.2	1,211.79
42	226.0	36.2	8.2	1,192.14
44	225.0	36.0	8.2	1,164.18
45	210.0	40.4	8.2	1,267.81
46	224.0	36.4	8.0	1,181.26
47	226.0	37.0	8.0	1,179.72
48	226.8	36.0	8.0	1,161.10
50	210.0	40.0	6.6	1,311.66
52	228.0	36.0	8.2	1,177.15
53	203.0	40.6	6.0	1,165.81
54	(*)	(*)	(*)	(*)
57	225.6	36.0	7.6	1,248.54
58	225.0	36.3	7.6	1,248.54
59	225.0	36.3	5.7	1,107.39
60	220.4	32.0	7.7	1,146.31
61	220.4	32.0	7.7	1,154.02
62	221.7	34.5	7.5	1,121.53
63	222.0	34.6	7.5	1,081.58
64	220.8	34.6	7.5	1,086.62
65	219.6	34.7	7.4	1,086.56
66	225.0	36.3	5.3	1,107.39
67	225.0	36.8	6.2	1,146.05
68	(*)	(*)	(*)	(*)
69	226.0	36.6	6.6	1,133.53
70	226.0	36.0	6.6	1,164.15
72	227.0	36.6	6.6	1,171.60
74	226.0	36.0	6.5	1,161.77
75	226.6	36.3	6.7	1,187.10
76	224.0	36.4	6.6	1,113.47
77	226.5	36.0	6.6	1,123.63
78	226.0	36.6	6.8	1,151.06
79	226.0	36.0	6.8	1,163.78

* Not known.

2108 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

List of barges that arrived at St. Louis during the year 1890—Continued.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	
80.....	227.7	36.2	6.8	1,144.13
81.....	226.6	36.0	6.6	1,118.74
82.....	226.0	36.0	6.8	1,101.11
83.....	226.0	36.0	6.6	1,105.29
84.....	226.0	36.0	6.6	1,101.63
85.....	226.4	36.0	6.7	1,102.45
86.....	225.5	36.0	6.6	1,127.97
87.....	226.0	36.6	6.6	1,123.99
88.....	226.0	36.4	8.2	1,202.23
89.....	227.7	36.4	8.0	1,174.62
90.....	216.7	36.0	7.9	1,079.81
91.....	202.7	35.0	7.6	996.96
92.....	216.8	36.0	8.0	1,154.49
93.....	228.0	37.0	8.2	1,218.76
94.....	228.0	36.6	8.4	1,221.57
95.....	228.4	37.0	7.3	1,220.91
96.....	227.7	37.0	7.2	1,220.60
97.....	225.5	36.5	8.1	1,185.64
98.....	228.4	36.4	8.8	1,237.12
99.....	226.0	36.8	8.2	1,141.80
100.....	228.6	36.6	9.0	1,274.81
101.....	225.0	35.0	5.3	860.31
102.....	225.0	35.0	5.3	860.31
103.....	225.0	36.0	6.6	835.31
104.....	225.0	36.0	6.6	835.31
105.....	227.8	31.2	6.0	1,007.27
106.....	227.8	31.2	6.0	1,012.53
William Gordon.....	227.7	36.6	6.6	1,262.01
William Towle.....	202.0	35.6	5.2	348.15
Wash. Honshall.....	(*)	(*)	(*)	(*)
W. C. Mahan.....	(*)	(*)	(*)	(*)
Wood.....	(*)	(*)	(*)	128.10
W. H. Brown's Sons.....	(*)	(*)	(*)	(*)
No. 23.....	(*)	(*)	(*)	(*)
27.....	(*)	(*)	(*)	(*)
32.....	(*)	(*)	(*)	(*)
34.....	(*)	(*)	(*)	(*)
35.....	(*)	(*)	(*)	(*)
37.....	(*)	(*)	(*)	(*)
38.....	(*)	(*)	(*)	(*)
43.....	(*)	(*)	(*)	(*)
44.....	(*)	(*)	(*)	(*)
45.....	(*)	(*)	(*)	(*)
Yantis.....	(*)	(*)	(*)	(*)

* Not known.

List of scows that arrived at St. Louis during the year 1890.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	
Alaska.....	(*)	(*)	(*)	(*)
Barrett No. 86.....	(*)	(*)	(*)	(*)
Charlie.....	(*)	(*)	(*)	(*)
Emma Wilson.....	(*)	(*)	(*)	(*)
Geese.....	(*)	(*)	(*)	(*)
J. Flowerce.....	200	28.8	8	414.69
J. Bowers.....	224	34.6	8	568.71
Joy Brothers (7 in all, known by numbers).....	(*)	(*)	(*)	(*)
J. Walton & Co's. (127 in all, known by numbers).....	(*)	(*)	(*)	(*)
Little Dan.....	(*)	(*)	(*)	(*)
Matt.....	(*)	(*)	(*)	(*)
Matt No. 2.....	(*)	(*)	(*)	(*)
McCormick No. 8.....	(*)	(*)	(*)	(*)
Rene McCready.....	(*)	(*)	(*)	(*)
R. G. Terrell.....	(*)	(*)	(*)	(*)
Saltsman, Nos. 1 and 2.....	(*)	(*)	(*)	(*)
Sitka.....	(*)	(*)	(*)	(*)
Snow.....	(*)	(*)	(*)	(*)
St. Croix.....	(*)	(*)	(*)	(*)
Ukon.....	(*)	(*)	(*)	(*)
V. W. Flowerce.....	200	28.8	8	414.69
Whitne.....	(*)	(*)	(*)	(*)
W. H. Brown's Sons (24 in all, known by numbers).....	(*)	(*)	(*)	(*)
Zero.....	(*)	(*)	(*)	(*)

* Not known.

Y 3.

IMPROVEMENT OF HARBOR AT ST. LOUIS, MISSOURI.

The river and harbor act of 1888 contained a provision calling for an examination and estimate for the improvement of St. Louis Harbor. A report was submitted from this office under date of December 22, 1888, for the improvement of the harbor at an estimated cost of \$182,000. It was recommended that this amount be expended in the portion of the harbor below Bissells Point and above the Eads Bridge. In the river and harbor act of September 19, 1890, the above amount, \$182,000, was appropriated for "improving the harbor at St. Louis, Mo."

The approved project consisted in a contraction of the width of the river by hurdles for a distance of 13,000 feet to an average width of 2,000 feet, in order to remove some trouble due to middle bars, which interfered with navigation.

Appropriations for the improvement of St. Louis Harbor had been made as far back as 1836, and a longitudinal stone dike was built at that time near the head of the present works by Capt. R. E. Lee, Corps of Engineers. Other work done by the United States consisted in the building of stone dikes normal to the current, in the closing of Cahokia Chute, and the revetment and protection of the bank in Sawyer Bend.

Work under the present project was begun on March 13, 1891, and completed as far as practicable on June 9, 1891. The work consisted in the construction of 11 hurdles varying in length from 325 to 2,075 feet, the total length of hurdle constructed being 12,400 linear feet. The hurdles are numbered from the upper part of the work downstream. Hurdle No. 5 was omitted, owing to the fact that it would have interfered with the ferry landing, and a portion of No. 8, the outer end, was left incomplete, owing to the depth of water. No. 5 will be built and No. 8 completed during this working season.

No special difficulty, except deep water, was encountered. At the beginning of the work some interference from drift was met with, but by sinking what had accumulated above Hurdles 1 and 2 this was overcome and the sunken drift served the purpose of wattling.

The work has been in position too short a time to form an idea of its effect, but it will undoubtedly be of great benefit to this portion of the harbor.

This is one of the few cases in which the amount asked for in a preliminary estimate has been appropriated, and the advantage of this method of appropriating is shown by the immediate completion of the work, thus avoiding the losses and unsatisfactory results of incomplete work.

The amount expended up to June 30, 1891, including outstanding liabilities, was about \$130,000, leaving a balance of about \$50,000 available for completing the work and any extension or repairs which may become necessary in the future. No further appropriation for this estimate is needed.

The material used in the work was purchased in connection with that for improvement of Mississippi River between Illinois and Ohio rivers, full details of which are given in the report on that work.

A portion of the repairs to the plant belonging to the improvement of the Mississippi River which was used on this work was paid for from this appropriation and five new-model barges were contracted for, but had not been finished at the close of the year, this being authorized by approved project of September 30, 1890.

2110 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

There are submitted herewith the reports of Mr. D. M. Currie, assistant engineer, and Mr. John O. Holman; also plate III, by reference to which all details and particulars can be obtained.

The commercial statistics will be found in the report on improvement of Mississippi River between Illinois and Ohio rivers.

Money statement.

Amount appropriated by act approved September 19, 1890	\$182,000.00
June 30, 1891, amount expended during fiscal year	109,303.77
July 1, 1891, balance unexpended	72,696.23
July 1, 1891, outstanding liabilities	\$41.06
July 1, 1891, amount covered by uncompleted contracts	20,892.17
	<hr/> 20,933.23
July 1, 1891, balance available	51,763.00

REPORT OF MR. D. M. CURRIE, ASSISTANT ENGINEER.

ST. LOUIS, MO., *June 30, 1891.*

MAJOR: I have the honor to submit the following report upon the improvement of the harbor of St. Louis, Mo., for the fiscal year ending June 30, 1891, and to transmit the report of Mr. John O. Holman, superintendent in local charge, which is intended to form part of it.

This work consists of a series of hurdles numbered 1 to 12, as shown on the accompanying sketch. No. 5 and 430 feet of the river end of No. 8 were not built. The others aggregate 12,400 feet, and were finished, with the exception of wattling. This was placed to the stage of 12 feet above low-water on Nos. 9 to 12, and drift was sunk on Nos. 1 to 4, which sufficiently checked the flow of water.

Reference is made to the accompanying report of Mr. Holman for further details.

PROCURING MATERIAL.

Brush.—Brush was procured by hired labor by a party organized under the local supervision of Mr. C. D. Lamb, whose report is transmitted with that of operations for the general improvement of the Mississippi River between the Illinois and Ohio rivers, to which reference is made for details.

Piles.—Piles were procured by contract, delivered at the work.

Stone.—Stone was procured by contract, delivered on Government barges at Grafton, Ill.

Other material was procured by contract, delivered at the supply depot, foot of Arsenal street, when needed in large quantities, and by purchase when only small quantities were required.

The steamer *General Gillmore* and other plant belonging to general improvement of this section of the river was used in connection with this work.

Very respectfully, your obedient servant,

D. M. CURRIE,
Assistant Engineer.

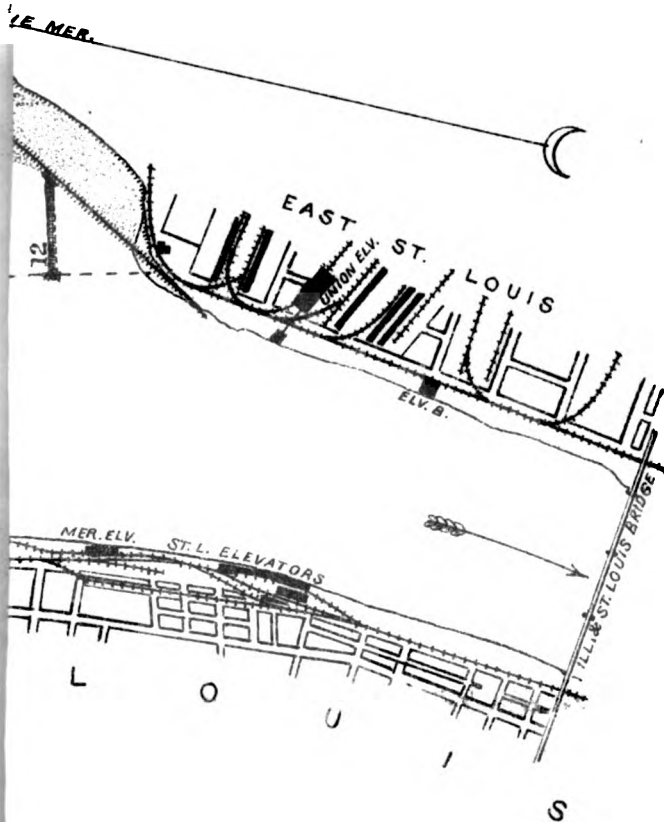
Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. JOHN O. HOLMAN, SUPERINTENDENT.

ST. LOUIS, MO., *June 30, 1891.*

MAJOR: I have the honor to submit the following report of the operations for improving the harbor at St. Louis, Mo., for the fiscal year ending June 30, 1891.

The project consists of 12 hurdles on the Illinois side, between the east approach of the Merchants' Bridge and the head of Bloody Island. The hurdles are spaced 1,000 feet apart perpendicular to the new river or shore line, which reduces the river to a width of 1,700 feet at No. 1, the upper hurdle, and 2,200 feet at No. 12.



*U.S. Engineer Office, St. Louis, Mo. July 17, 1891.
Annual report for the year ending June 30, 1891.*

A. M. Miller
Major Corps of Engineers, U.S.A.

THE
BETWEEN
AND THE
WORKS
SCALE

A survey to locate the hurdles was made in February, shortly after the construction work was placed in my charge.

Field work was begun March 13, and continued without interruption until the close of the spring season, June 9. During that period of nearly 3 months all of the hurdles were completed with the exception of No. 5, which was omitted for the time being, to preserve a landing at Venice, and the river end of No. 8, where the water was too deep for favorable construction.

The length and work performed on each hurdle is given in the following table:

Table of work done.

Hurdle number.	Con- structed.	Piles.	Driven depth.	String- ers.	Mattress.	Revet- ment.	Watting.
	<i>Linear ft.</i>	<i>No.</i>	<i>Feet.</i>	<i>No.</i>	<i>Sq. feet.</i>	<i>Sq. feet.</i>	<i>Sq. feet.</i>
1	750	261	4, 715	39	60, 425	11, 080	.....
2	325	226	3, 492	45	52, 545	10, 000	.....
3	490	358	5, 417	85	108, 350	10, 000	.....
4	850	527	8, 118	103	79, 150	1, 800	.....
5							
6	1, 080	520	8, 222	104	88, 800	8, 150	.....
7	1, 270	633	10, 076	136	101, 200	10, 000	.....
8	1, 280	599	9, 290	118	88, 350	4, 000	.....
9	1, 900	828	12, 409	165	130, 700	2, 500	11, 870
10	2, 075	823	12, 403	146	142, 075	4, 000	9, 530
11	1, 600	547	8, 218	86	111, 200	6, 800	9, 350
12	800	299	4, 629	66	56, 800	4, 000	6, 200
Total	12, 400	5, 591	86, 989	1, 093	1, 014, 395	67, 130	36, 750

The form of hurdle and method of construction were not changed. Two rows of piles were driven in each hurdle, 20 to 27 feet apart, according to the depth of water. The piles in the upper or drift row were driven 6 feet apart, the tops pulled together with a longitudinal stringer bolted to them on the downstream side not lower than the 20-foot stage. The brace pile was then driven 6 or 8 feet below, pulled over to the stringer and bolted to it, forming a clump of 3 piles every 12 feet. The hurdle row was driven after the mattress was sunk, the piles spaced 6 feet apart, with the stringer on the up-stream side, to which were bolted the brace piles driven every 12 feet. The hurdle was strengthened by cross stringers placed at varying intervals from the shore to the river end.

With the river at an 18-foot stage or lower the drift-row piles were carried to the 25-foot stage, the stringer and hurdle piles to the 20-foot stage, changing with the river when above that stage.

For a length of 400 feet at the shore ends of Nos. 1, 9, and 11, and 700 feet of No. 10, only the hurdle row was driven, the depth of water not requiring the drift row.

A woven mattress of brush, 65 feet in width, was placed below the drift row. At the river end of No. 3 and the shore end of No. 8 it was 80 feet in width. A protection mattress for the shore end was placed on Nos. 1, 2, 3, 6, and 7. They were made 200 feet long by 80 feet in width, half above and half below the hurdle row. A T-head mattress was placed just outside of the river line on Nos. 3 to 12 to protect the river ends from scour. These mattresses were 90 feet in length by 80 feet in width, with the upper edge 20 feet above the line of the drift row.

Riprap was placed at the shore end of all the hurdles to protect them from scour during a high stage of the river, the extent of revetment placed varying from 3,150 to 11,080 square feet, according to the nature of the bank protected.

On the lower hurdles, Nos. 9 to 12, the current was checked by a watting mattress placed against the hurdle-row piles. These mattresses were made in lengths of about 200 feet, the width varying with the depth of water, so that when placed in an up-right position the upper edge would be at the 12-foot stage. On the upper hurdles, Nos. 1 to 4, the current was greatly checked by sinking the drift wood collected above them.

Only a few of the foremen and enough laborers to take care of the plant in rainy weather were subsisted. The maximum number of persons employed was 470, during the latter part of April.

A sketch of the locality accompanying this report shows the location of the work done.

Very respectfully, your obedient servant,

JOHN O. HOLMAN,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

Y 4.

IMPROVEMENT OF GASCONADE RIVER, MISSOURI.

The improvement of this stream has consisted in the removal of obstructions to navigation in the shape of leaning timber, snags, stumps, etc., and the construction of low wing-dams, to facilitate the passage of boats over the shoals during low stages of water.

The work was begun in 1880, and has been continued when funds were available up to the present time.

As the money appropriated for this work was not available until late in the fall, it was impossible to do any work during the low-water season, and operations were postponed until the following year. Up to the close of the fiscal year a suitable stage had not been obtained, consequently but little work was done, and that consisted in the repair of plant and in obtaining a supply of brush, stone, and timber to be used in raising the crest of dam at Pryor's Mill. A small force was employed in quarrying stone and procured 276 cubic yards, which was placed ready for depositing in Pryor's Dam when the stage of water will admit of the work.

The details of the season's operations are shown in the report of assistant, Mr. J. W. Beaman, which is forwarded herewith and to which attention is invited.

The work has been of great benefit to navigation of the river, especially to the rafting interests, and the river is now in fairly good navigable condition from the mouth to Indian Ford.

No work has been done on the stretch of river extending from Indian Ford to Arlington, and which is in poor condition owing to leaning timber and snags. A large portion of the railway ties, and some steamboat commerce, pass over this portion, and it would therefore seem desirable to remove these obstructions.

There are also a number of shoals between the mouth and Indian Ford which need contraction works. At the shoals where such works have been placed the conditions have been so much improved that it would seem to warrant a reasonable expenditure for similar works at other localities.

With the funds now on hand it is proposed to raise the dam at Pryors Mill and remove obstructions as far as they will admit. With the appropriation asked for fiscal year ending June 30, 1893, it is proposed to clear the river of obstructions above Indian Ford and construct contraction works at such shoals as may seem most advisable.

The estimated cost of this improvement was \$50,000, and the former appropriations are—

By act of—		By act of—	
June 14, 1880.....	\$5, 000	August 5, 1886.....	\$7, 500
March 3, 1881.....	10, 000	August 11, 1888.....	5, 000
August 2, 1882.....	10, 000	September 19, 1890.....	4, 000
July 5, 1884.....	5, 000		

Money statement.

July 1, 1890, balance unexpended.....	\$427. 65
Amount appropriated by act approved September 19, 1890.....	4, 000. 00
	<hr/>
June 30, 1891, amount expended during fiscal year.....	4, 427. 65
	543. 61
July 1, 1891, balance unexpended.....	<hr/>
	3, 884. 04

{ Amount that can be profitably expended in fiscal year ending June 30, 1893 10, 000. 00
 { Submitted in compliance with requirements of sections 2 of river and
 { harbor acts of 1866 and 1867.

REPORT OF MR. J. W. BEAMAN, ASSISTANT ENGINEER.

JEFFERSON CITY, MO., June 30, 1891.

MAJOR: I have the honor to submit the following report upon the improvement of the Gasconade River, Missouri, for the fiscal year ending June 30, 1891.

After the plant used in the snagging operations during the latter part of June of the last fiscal year had been returned to Gasconade City, two men were employed in its repair from July 1 until August 14. Upon the latter date, the plant having been repaired, it was placed in charge of a watchman and the repairing force was discharged.

On May 4, in accordance with verbal instructions preparations were made to put flatboat and tools in order for work projected at Pryor's Mill. In this work two men were occupied until May 16.

On this date the improvement plant in charge of two men was taken in tow by boat *Jumbo* and towed to the foot of Pryor's Island. The work of quarrying rock commenced May 18 and continued up to the 26th of June. During this time 276 cubic yards of rock was quarried and placed ready for depositing in Pryor's dam when the stage of water will admit of the same.

When the water, which is now about 2½ feet deep on the crest of the dam, shall have fallen somewhat the dam at Pryor's Mill will be repaired by placing rock, timber, and brush where needed, so as to raise the structure not to exceed 18 inches above the present height of dam. With this addition it is expected that sufficient water will be deflected into the left chute as to render it navigable at a lower stage of the river than under the present condition is possible.

Upon the completion of the work projected at Pryor Mill, other portions of the Gasconade River will require the employment of a small party in snagging and other work until the close of the working season in November next.

Attention has been called by the Hermann Ferry and Packet Company to the condition of the river channel and banks above Indian Ford and below Arlington. Nothing has ever been done by the Government to improve the river above Indian Ford, which is 78 miles above the mouth.

A large part of the railway ties rafted, and some steamboat commerce, pass over this upper river; it is therefore desirable that the overhanging trees be removed from the channel banks and that the snags be removed from the channel way so that those interested may be protected.

The present high water will probably deposit snags in the channel and so undermine the banks in the bends as to cause some needed work of removal of snags from the shoals and overhanging trees from the banks, along the whole course of the river, during the next low-water season.

A number of shoals between the mouth of the river and Indian Ford need contraction works as soon as there is sufficient money available for their construction. The three shoals where such works have been placed show such an improved condition of channel depth as to warrant a reasonable expenditure of money for like works at other shoals where the channel way has become so wide as to render its navigation difficult at the lower stages of the river.

For snagging operations and contraction works upon the hundred miles of river below Arlington, \$15,000 could be expended to advantage.

The statistics which accompany this report indicate a healthful condition of river trade, which should be protected and fostered.

Very respectfully, your obedient servant,

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

J. W. BEAMAN,
Assistant Engineer.

COMMERCIAL STATISTICS, GASCONADE RIVER, MISSOURI.

Articles.	Fiscal year ending—	
	June 30, 1890.	June 30, 1891.
	Tons.	Tons.
Hay, grain, flour, seeds, etc.....	8, 185	2, 132
Lumber, logs, wood, railway ties, etc.....	20, 910	24, 702
Live stock.....	164	255
Produce.....	7	7
Salt.....	23	33
Iron, nails, etc.....	45	.....
Farm machinery.....	112	119
General merchandise.....	639	263
Total.....	25, 085	27, 511

Increase 1891 over 1890 equals 2,426 tons.

2114 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

List of steam-power boats engaged in commerce on Gasconade River during the year ending June 30, 1891.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	
Pin Oak	95.0	17.5	2.2	43.05
Royal	86.6	24.0	3.0	44.82
Jumbo	57.0	16.0	2.5	25.00
Fawn	85.0	18.0	3.0	78.00

Y 5.

IMPROVEMENT OF OSAGE RIVER, MISSOURI.

The project for the improvement of this stream has consisted in the removal of obstructions to navigation, such as snags and leaning timber, dredging channels through shoal places, and the construction of cross and wing dams to concentrate the water over shoal places. The construction of a lock and dam near the mouth was also authorized by the last river and harbor act.

But little work was done during the year, owing principally to the late date at which the new appropriation became available.

The worst obstruction to navigation during the year was at Brenneke Shoal where the low water caused serious trouble. Several attempts were made to overcome the difficulty, but before they were successful sudden rises in the river rendered further efforts unnecessary.

A personal examination of this river from the mouth to Warsaw, a distance of 174 miles, was made in March, 1891. The river was found to be in good navigable condition and but few obstructions were observed in the channel. Above Tusculumbia the banks are covered with overhanging trees which should be removed. There is but little navigation of the river above Tusculumbia by large boats, so that a large expenditure for the improvement of this portion of the river would not be warranted.

A report on proposed location of lock and dam on this river, near its mouth, with estimate of cost, also tracing showing plan, elevation, and sections, was forwarded during the year.

The general dimensions of the lock proposed are as follows:

Total length	feet..	339½
Width	do...	50
Miter sill to miter sill	do...	275
Spring of arch to head of lower recess	do...	240
Lift	do...	8½

This lock will conveniently pass a boat 240 feet in length over all and 48 feet in breadth over all, thus being of ample size to accommodate any boat navigating the river.

The proposed dam is 800 feet long.

The effect of this lock and dam will be to give an uninterrupted channel of 4 feet for the whole year from the mouth to Dixon Shoal, a distance of 20 miles.

The estimated cost of the lock and dam is as follows:

Lock	\$141,139.29
Dam	26,582.52
Land and keeper's dwelling	2,500.00
Engineering and contingencies	17,022.19
Total	187,244.00

Estimates are being prepared of the cost of a series of locks and dams designed to give depths of 4 feet and 6 feet, respectively, for navigation in this river.

Gauges were established at Osage City and Brenneke Shoal, and a series of discharge observations were commenced at the latter locality.

The details of the work are given in the report of Mr. J. W. Beaman, assistant engineer, forwarded herewith.

The readings of the gauge at Tuscumbia were kept up during the year, and are given in the accompanying table.

The work done has been of great benefit to the navigation of the river, rendering it safer and also enabling steamboats to navigate it at lower stages of water than formerly, and tending to prolong the boating seasons.

During the coming season it is proposed to expend the amount appropriated for snagging in the last river and harbor act in that manner, and of the amount appropriated for lock and dam as much as may be necessary for gauging the river and acquiring the land required, the remainder to be retained until further appropriations amount to the estimated cost of lock, or \$140,000.

Of the amount asked for fiscal year ending June 30, 1893, it is proposed to expend \$10,000 in removing obstructions, dredging, and building wing dams when found necessary, and \$100,000 in constructing lock.

The former appropriations are:

By act of—		By act of—	
March 3, 1871.....	\$25,000	June 14, 1880.....	\$30,000
June 10, 1872.....	25,000	March 3, 1881.....	20,000
March 3, 1873.....	25,000	August 5, 1886.....	10,000
June 23, 1874.....	25,000	August 11, 1888.....	5,000
June 18, 1878.....	20,000	September 19, 1890.....	55,000
March 2, 1879.....	20,000		

Money statement.

July 1, 1890, balance unexpended.....	\$2,531.40
Amount appropriated by act approved September 19, 1890.....	55,000.00
	<hr/>
June 30, 1891, amount expended during fiscal year.....	57,531.40
	3,460.87
July 1, 1891, balance unexpended.....	54,070.53
July 1, 1891, outstanding liabilities.....	20.67
	<hr/>
July 1, 1891, balance available.....	54,049.86
	<hr/>
{ Amount (estimated) required for completion of lock and dam	137,244.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	110,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.....	

REPORT OF MR. J. W. BEAMAN, ASSISTANT ENGINEER.

JEFFERSON CITY, MO., *June 30, 1891.*

MAJOR: I have the honor to submit the following report upon the improvement of the Osage River, Missouri and Kansas, for the fiscal year ending June 30, 1891:

No river improvement work proper has been done upon the Osage River since the fall of 1889.

2116 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

In October, 1890, there was such a shallow depth of water over Brenneke Shoal as to occasion serious trouble and loss to the Missouri and Osage River Packet Line, and the attention of your office was called to the matter. After much difficulty experienced in the effort to secure men and teams to work in the cold water, three men and two teams began work November 10. In former years gravel deposits have been removed from the channel way by road scrapers drawn by horses or mules. The same plan was tried at Brenneke Shoal. It was found, however, upon driving the teams upon the shoal that they mired to their bodies, rendering work impossible, and the attempt was abandoned and the men were discharged November 12. A rise in the river a few days later relieved the difficulty.

In January the water was again so low that Capt. R. M. Marshall, of the Missouri and Osage River Packet Line, by letter of January 17, called attention of your office to the grounding of one of their steamboats on the shoal, and a request for some relief was made. Arrangements were then made with the Missouri and Osage River Line to remove the deposit with one of their steamboats. Before the company had perfected its preparations to begin work a rise in the river again relieved the difficulty.

Again in March the water was so low as to cause the grounding of a barge loaded with gravel, which was taken over the shoal after a delay of 24 hours.

On March 21 there was a rise from backwater from the Missouri, followed by a head rise, since which date there has been an excellent boating stage for the smaller Osage River boats and for most of the time for boats of the size of the *Helena* and *Benton*.

Between March 24 and 27 an examination of the river was made from its mouth to Waraw, a distance of 174 miles. In this examination, which was made under your immediate personal direction, the steamer *Helena* was utilized. The river was found to be in good navigable condition throughout the whole distance passed over. The stage of water as indicated by the gauge at Osage City was 8 feet above standard low water on March 27.

There has been no improvement work done upon the river above Tuscumbia since 1883. As a consequence the banks are covered in places with overhanging trees which should be removed in order to make navigation more safe for the larger river boats; still there is very little navigation of the river by large boats above Tuscumbia, and the necessities of commerce would not warrant a very large outlay of money in the improvement of this upper portion of the river.

At a few points below Tuscumbia there are upon the banks some overhanging trees.

At Moore Flats and Hoskins Shoal on March 24 there were a few stumps and snags lying in the channel way, which should be removed if still there at the next low water.

The chief river obstruction as developed by the examination and previous complaint is the gravel deposit at Brenneke Shoal. This deposit will cease to be an obstruction as soon as the lock and dam projected has been completed at the foot of the shoal.

Upon November 24, in accordance with your letter of instructions of November 20, I proceeded to Louisville, Ky., and afterwards to Mt. Carmel, Ill., and at these points obtained working drawings of the lock and dam under construction in the Wabash River near Mt. Carmel. In this work I was engaged until December 24, when I returned to my station at Jefferson City. A complete set of working drawings were obtained and duly transmitted to your office on December 31.

In accordance with verbal instructions upon April 1 a small force was employed to repair and launch the flatboats at Lisle Town Landing, and in moving the Osage River improvement plant to Brenneke Shoal. At this point a gauge was established and a base line surveyed, and observations commenced for the determination of river discharge. These observations have continued up to the close of the year, and will continue until the lowest stages of the river have been observed.

In March the gauge at Osage City was repaired and an observer was appointed who has kept a record of the gauge readings at 8 a. m. daily since March 5.

In conclusion it may be stated that \$5,000 will be sufficient to keep the river in good navigable condition during the next 2 years. Ample provision should be made so that the projected lock and dam at the foot of Brenneke Shoal may be completed at the earliest practicable day.

Very respectfully, your obedient servant,

J. W. BEAMAN,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

Record of gauge at Tuscomb, Mo., for fiscal year ending June 30, 1891.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1.....	1.70	1.30	7.35	8.15	2.35	4.20	5.05	4.55	11.00	13.70	11.45	9.90
2.....	1.00	1.15	5.80	7.00	2.65	3.98	4.80	4.50	9.45	13.55	9.20	10.75
3.....	1.45	1.00	5.15	5.80	2.50	3.55	5.00	4.45	7.60	13.10	9.30	12.30
4.....	1.35	.90	4.85	5.05	2.35	3.30	5.75	4.35	6.15	12.40	10.15	12.95
5.....	1.20	.75	3.60	4.85	2.25	3.15	6.15	4.30	5.65	10.65	9.20	14.50
6.....	1.10	.65	2.50	5.40	2.15	3.00	6.05	4.20	5.10	8.60	7.50	19.70
7.....	1.00	.55	2.05	8.15	2.10	2.90	5.80	4.40	4.75	7.05	6.75	26.10
8.....	.90	.50	1.95	9.70	2.05	2.80	5.95	4.40	4.55	6.25	5.95	27.85
9.....	.80	.45	2.25	9.75	2.15	2.70	5.75	4.55	4.30	5.75	5.35	27.00
10.....	.70	.50	2.70	8.20	2.30	2.65	5.20	5.90	4.30	7.10	4.90	26.10
11.....	.55	.45	3.40	6.50	2.70	2.55	4.65	6.75	4.20	10.30	4.50	22.85
12.....	.45	.35	3.25	5.30	3.95	2.45	4.40	6.45	4.20	11.25	4.15	18.40
13.....	.40	.35	3.10	4.95	4.50	2.35	4.30	5.70	4.25	12.30	3.90	17.15
14.....	.35	.30	3.00	4.50	4.80	2.35	4.50	5.00	4.30	12.40	3.65	15.75
15.....	.35	.25	2.85	4.35	4.95	2.40	4.75	4.60	4.50	13.30	3.40	14.60
16.....	.30	.20	2.65	4.45	4.60	2.50	4.80	4.25	4.75	13.50	3.15	13.65
17.....	.35	.40	4.35	7.90	4.75	2.70	4.90	4.10	4.60	13.75	3.15	11.65
18.....	.45	.60	5.40	10.05	5.60	2.80	5.00	3.85	4.75	14.65	3.45	11.55
19.....	2.65	.80	5.70	10.15	8.40	2.80	5.15	3.80	5.80	15.20	4.75	12.30
20.....	4.10	1.95	5.90	10.10	13.15	2.55	5.25	8.50	9.55	15.15	4.30	13.85
21.....	3.80	2.10	6.80	9.75	13.00	2.40	5.55	12.75	11.10	15.25	4.35	22.50
22.....	2.65	2.30	7.25	8.80	12.35	2.30	5.70	16.70	11.45	17.35	4.30	24.50
23.....	4.45	3.90	7.15	7.50	11.40	2.30	6.35	17.90	11.40	20.30	4.25	28.65
24.....	5.40	4.40	6.50	6.10	10.75	2.15	6.90	16.85	10.90	20.05	4.15	21.90
25.....	4.55	3.75	6.85	4.70	10.05	2.10	7.15	15.60	10.70	19.10	3.95	19.70
26.....	3.50	3.65	6.90	4.15	8.90	2.10	6.85	14.15	12.25	17.35	6.45	17.60
27.....	2.70	4.50	6.10	3.90	7.65	2.05	6.80	13.65	12.15	15.25	8.70	16.00
28.....	2.30	7.35	8.65	3.70	6.30	2.90	5.65	12.40	12.25	14.80	10.35	15.60
29.....	1.95	6.30	9.90	3.50	5.40	6.70	5.20	.....	12.70	13.60	11.40	15.65
30.....	1.70	9.10	9.10	3.30	4.65	6.35	4.90	.....	13.20	13.80	11.30	15.35
31.....	1.50	8.85	.....	3.10	.....	5.65	4.70	.....	13.65	.....	10.75	.....

COMMERCIAL STATISTICS, OSAGE RIVER, MISSOURI AND KANSAS.

Articles.	Fiscal year ending—	
	June 30, 1890.	June 30, 1891.
Hay, grain, etc.....	Tons. 14,450	Tons. 4,573
Lumber, logs, railway ties, etc.....	55,549	87,698
Live stock.....	850	735
Salt.....	262	773
Iron, nails, etc.....	100	87
Barytes.....	1,200	2,890
Produce.....	.....	218
Farm machinery.....	500	.....
General merchandise.....	2,000	2,100
Total.....	74,911	99,078

List of steam-power boats engaged in commerce on Osage River during the year ending June 30, 1891.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
Benton.....	<i>Fect.</i> 197	<i>Fect.</i> 23	<i>Fect.</i> 5	398.08
Helen.....	194	23	4.5	352.30
John R. Hugo.....	127	20	3	186.88
Frederick.....	85.4	14.3	3	32.50
Edna.....	80	13	3	90.85
Black Diamond.....	72.5	14.4	2.3	18.40
Annie Dell.....	80	16	2.5	19.50

Y 6.

IMPROVEMENT OF KASKASKIA RIVER, ILLINOIS.

The improvement of this stream contemplates the removal of snags and other obstructions from the channel and the deepening of the river over the shoals and bars by means of dredging and excavating from the mouth to the Baldwin Bridge.

An examination and survey of the river, with a view to its improvement, was made in 1888, and the first appropriation of \$6,000 was contained in the river and harbor act of September 19, 1890.

As the low-water season had passed by the time the project for the expenditure of this amount was approved it was decided to postpone operations until the low-water season of the coming year, so that no work was done on this improvement for the fiscal year ending June 30, 1891.

With the amount recommended to be appropriated for the fiscal year ending June 30, 1893, it is proposed to complete this improvement as contemplated. The estimated cost of the improvement was \$10,500.

Money statement.

Amount appropriated by act approved September 19, 1890	\$6,000.00
July 1, 1891, balance unexpended	6,000.00
<hr/>	
{ Amount (estimated) required for completion of existing project	4,500.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	4,500.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS, KASKASKIA RIVER, ILLINOIS, 1890.

	Tons.
Coal	60
Cordwood and lumber	2,105
Flour, grain, etc.	5,837
Merchandise	400
Total	8,402

List of steam-power boats engaged in commerce on Kaskaskia River, Illinois, during the year ending December 31, 1890.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	
Dolphin	135.8	22.8	4.8	156.16
Little Nick	60	10	3	14.22
Mary M. Michael	143.3	26.3	4.4	234.44
Nick Sauer	100	18	4	99.27
R. A. Speed	124	22	4.2	210.13

APPENDIX Z.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN DES MOINES RAPIDS AND MOUTH OF ILLINOIS RIVER.

REPORT OF MAJOR E. H. RUFFNER, CORPS OF ENGINEERS, OFFICER IN
CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER
DOCUMENTS RELATING TO THE WORK.

IMPROVEMENT.

1. Mississippi River between Des Moines Rapids and mouth of Illinois River.

EXAMINATION.

2. Mississippi River at Warsaw, Illinois, with a view of removing bar.

Z 1.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN DES MOINES RAPIDS AND MOUTH OF ILLINOIS RIVER.

UNITED STATES ENGINEER OFFICE,
Quincy, Ill., July 8, 1891.

GENERAL: The following report of operations for the fiscal year ending June 30, 1891, for improving Mississippi River between the Des Moines Rapids and the mouth of the Illinois River is respectfully submitted. The year began with a good stage of water in the river and with a balance of funds on hand sufficient to justify some work of construction.

Accordingly it was decided to begin the works of improvement designed for Cottonwood Beach, 2 to 5 miles above Quincy. After preparations were made and material gotten, the water fell so that it was only possible to put in shore protections. Two pieces, aggregating 1,660 feet in length, at the foot of Cottonwood Island and consuming—

Rock.....	cubic yards..	2,446.4
Brush.....	do....	1,417.2
Total.....	do....	3,862.6

And one strip of 2,600 feet on the Illinois shore opposite containing—

Rock.....	cubic yards..	4,089.6
Brush.....	do....	2,328.0
Total.....	do....	6,417.6

And a beginning of the shore protection for a long wing dam higher up, taking—

Rock.....	cubic yards..	190.7
Brush.....	do....	25.0
Total.....	do....	215.7

exhausted the appropriation available, and work closed. In all, 4,460 feet of shore protection were laid during the season, consuming 10,496 cubic yards of material. This is less than $2\frac{1}{2}$ cubic yards to the running foot, and less than our usual average, but it stands well, holds the bank, and appears to be perfectly satisfactory. Complaint was made in August that navigation was impeded, although the gauge read not less than a foot higher than in 1889, and not less than 4 feet depth was found over the shoalest bars. The river rose slightly in September and October, and no difficulty was experienced. At no time was one bar markedly worse than another. To complete the repairs on our fleet, bids were invited for redecking the six model barges, and the following is the abstract of proposals:

Abstract of proposals for repairs to model barges, opened at 2 p. m., July 18, 1890, by Maj. E. H. Ruffner.

No.	Name and address of bidder.	Price.	Remarks.
1	E. R. Rook and T. S. Adams, Quincy, Ill.	\$5,910	Accepted and contract made. For each, for two or three barges.
2	J. R. Morgan, Clinton, Iowa.	7,050	
3	T. G. Isherwood, Le Claire, Iowa.	4,200	
4	Martin Von Hein, Le Claire, Iowa.	3,950	
5	Kahlke Brothers, Rock Island, Ill.	742	
6	John P. Geisler, Rock Island, Ill.	9,300	

Mr. Von Hein duly completed his contract, and the barges are now in excellent condition. To secure material for the season of 1891, bids were invited and opened January 8, 1891, with the following abstract:

Abstract for proposals for furnishing rock and brush during the season of 1891, opened by Maj. E. H. Ruffner, Corps of Engineers, at Quincy, Ill., at 2 p. m., January 1, 1891.

No.	Name and address of bidder.	Rock.			Brush.		
		Yards.	Price.	Place of delivery.	Yards.	Price.	Place of delivery.
1	E. Kimmell, Quincy, Ill.				19,000	<i>Cents.</i> 40	Near Quincy or Canton. Scott Landing.
2	H. P. Dodge, Atlas, Pike County, Ill.	19,000	\$0.74	Louisiana, Mo.	11,000	49	
					11,000	39	
3	Grafton Quarry Co., St. Louis, Mo.	19,000	.45	Grafton, Ill.			On river bank Scott Landing.
4	Frederick W. Menke, Quincy, Ill.*	2,000	.64	Quincy, Ill.			
		3,000	.69	Do.			
5	Reid, Brosi & Ebert, Quincy, Ill.*	10,000	.68 $\frac{1}{2}$	La Grange, Mo.			
6	Henry L. Hart, Louisiana, Mo.*	19,000	.54 $\frac{1}{2}$	Louisiana, Mo.	11,000	29 $\frac{1}{2}$	
7	Chas. C. Pratt and Robt. W. Young, Louisiana, Mo.	19,000	.55	Do.			
8	Geo. J. Ebert, Quincy, Ill.*	2,000	.64 $\frac{1}{2}$	Quincy, Ill.			
		2,000	.70	do do			
9	Hannibal Lime Co., Hannibal, Mo.*	5,000	.50	Hannibal, Mo.			
10	Zack Fielder, Hannibal, Mo.	5,000	.60	Do.			
		19,000	.70	Louisiana, Mo.			
		34,000	.80	La Grange and Quincy.			
11	Patterson Bros, Keokuk, Iowa.	19,000	.73	5 miles below Louisiana, Mo.			Louisiana, Mo.
		2,000	.85	Keokuk, Iowa.			
12	Wm. C. Swanwick, Keokuk, Iowa.	5,000	1.00	Hannibal, Mo.			
		25,000	1.25	La Grange, Mo.			
13	Jesse G. Fox, Carman, Ill.*						

* Accepted; contract made.

These contracts not furnishing enough rock for the season's work, further advertisement was had and proposals invited for 20,000 cubic yards. The following is the abstract:

Abstract of proposals for 20,000 cubic yards of rock, opened at 2 p. m., April 2, 1891, by Maj. E. H. Ruffner, at Quincy, Illinois.

No.	Name and address of bidder.	Amount offered.	Price.
		<i>Cubic yards.</i>	<i>Cents.</i>
1	Zack Fielder, Hannibal, Mo.....	20,000	80
2	Tigue & McCaffrey, Keokuk, Iowa*.....	10,000	69

*Accepted.

Contract with Messrs. Tigue & McCaffrey to deliver 10,000 cubic yards of rock on the barge, at Keokuk, Iowa, was entered into.

To carry out the clause in the appropriation bill providing for dredging in Quincy Bay, bids were invited by advertisement dated December 6, 1890, and opened January 6, 1891. The following is the abstract of proposals:

No.	Name and address of bidder.	Price per yard.
		<i>Cents.</i>
1	A. J. Whitney, Rock Island, Ill.....	15
2	H. S. Brown, Quincy, Ill. *.....	12.4

*Accepted.

Contract was entered into with Mr. H. S. Brown, who began work as early in the spring as was feasible and carried it on with his usual vigor. He is engaged in carrying out the project of 1879, and the present contract will, with the amount allotted (\$12,500), deepen all areas near the Quincy Bay Bridge and in the channel through Whipple or Cedar Creek Bar sufficiently for present needs of navigation. The remaining \$12,500 will be reserved for the present. Mr. Brown dug 34,763½ cubic yards up to June 30, 1891, about a third of his contract.

It is my especial recommendation that permission be granted to use so much of the \$12,500 reserved for Quincy Bay as may be necessary to construct a retaining levee on Whipple Creek Bar to hold the material dredged from the bay itself. The continual dredging of large quantities of material in Quincy Bay and depositing it in the main river is a positive damage to the latter. The levee proposed will also catch and retain material brought down the two creeks named, and which, especially after heavy storms, materially contributes to filling up the dredged areas.

The area proposed to be leveed is submerged at all but low stages of the water, and lies within the harbor lines. No expense should be incurred by the United States for acquirement of title, as I believe the patent for the land in question was never made out and the title probably rests in the United States. If the levee be constructed and subsequently dredging be required, the material can be deposited in the basin created and the bay will be benefited without injuring the river. No further appropriation for dredging in Quincy Bay is needed for the present.

CLARKSVILLE HARBOR, MISSOURI.

To carry out the clause in the river and harbor bill requiring the expenditure of \$15,000 as recommended by me, the United States dredge No. 2 was set at work there the last week in March, assisted by the launch *Iris* and steamer *Monarch*, hired for that purpose, and dug gravel along the front of Clarksville and above and below the town. The material varied very much in character, and in places was almost rip-rap. But again in many places it was but little better than sand and mud. Had the river remained at an average stage, instead of dropping in June to the lowest and next to the lowest place on the gauge, I presume more of the material dumped on the line of the dam would have remained. As it was the fall gave a strong scour and much was carried below the dam. The dredge suffered many accidents, and can not be said to have made as good a showing as it has made when newer. Work continued until the end of June, when the dredge was moved elsewhere. In all, there were dug and dumped upon the line of the dam, 1,600 feet long, from the head of Clarksville Island to the Illinois shore, 36,203 cubic yards of sand, mud, gravel, and rock. Probably one-fourth of this was entirely washed away, and another fourth is carried below the line of the dam. The remainder makes a good, solid dam, as far as it goes. The gap not filled by the dredge will be filled by the usual brush and rock dam, and when the low stage of water comes scrapers will be hired to distribute surplus material regularly along the dam, which will thus be widened and leveled as a causeway. Somewhat more than a third of the dam was raised above a $3\frac{1}{2}$ -foot stage by the dredge alone, and there is enough material available to level the whole when the time comes.

The *Success* and half of our barges, under charge of Assistant Engineer A. L. Richards, started work during the last week in March, and have been steadily engaged with reasonably good results. The contractor for material at Louisiana furnished rock and brush very promptly except during June. A cutting bank behind Buffalo Island, where some work was done in 1887, was held by 518 cubic yards of rock, and then the fleet protected the small tow-head at the foot of Hickory Chute, running a short dam to lower Fritz Island, as recommended by the Board of Engineers for Hickory Chute. Work then began on the protection of the shore necessary to secure the Sny Island Levee, as provided for in the appropriation bill. This stretch of about 3 miles begins at Scott's Landing, and all but about 2,600 feet of it was secured by June 30, when the fleet was transferred to Clarksville, as already noted. Particulars as to material will be found in the table later on. The fleet put in $24,313\frac{1}{2}$ cubic yards material in 3 months and 2 days.

The *Coal Bluff* and the remainder of the fleet have been employed in Cottonwood Island Reach, 3 to 5 miles above Quincy, with Overseer George Wolcott in charge. The rebuilding of the wheel of that boat, the last of the repairs on it, delayed beginning until April 9, when barges were delivered near quarries and men set to work cutting brush. Material came slowly, as contractors were not prompt, having only small contracts, and not until June was a good showing made. Cottonwood Island was connected with the Illinois shore by a closing dam 1,125 feet long, built on a high bar, at a good stage of the river. A short dam 250 feet long unites the two parts of Cottonwood Island, and a shore protection 650 feet long was carried around the head of the eastern half of the island. The building of a long wing dam, begun last year, from the

Illinois shore near the foot of the next island up the river, was resumed. This dam is 1,700 feet long, but as it rests in shallow water does not consume much material. The shore protection of the cutting bank opposite on the Missouri side was then begun and was about three-fourths finished when the month closed. With this piece all is done contemplated in this reach for this season. Lone Tree Crossing is better this year than for several past, the channel being straight and deep. The stage of water this spring was especially favorable for work in this reach. For 45 days the gauge read between 10.5 feet and 11.7 feet, not varying more than 14 inches, and the stage was the best possible for the character of the work. The dams were cheaply, accurately, and successfully built and desired scour occurred as the river fell. The following table shows work done and material used by the two fleets.

Dams and shore protections built in 1891 by the fleets of the Success and Coal Bluff tow boats.

	Length.	Rock.	Brush.	Total material.
	<i>Feet.</i>	<i>Cu. yds.</i>	<i>Cu. yds.</i>	<i>Cu. yds.</i>
Buffalo Chute shore protection	700	518.5	.....	518.5
Hickory Chute Tow-head protection	1,100	1,161.0	.....	2,138.0
Hickory Chute Tow-head closing dam	750	2,236.8	1,234.1	3,471.0
Sny Island Levee shore protection	13,600	11,246.2	6,939.8	18,186.0
Cottonwood Island closing dam	1,125	2,262.3	1,441.0	3,703.3
Do	250	1,249.2	467.3	1,716.5
Cottonwood Island shore protection	650	1,085.7	417.8	1,503.5
Wing dam opposite foot of Hogback Island, Illinois shore ..	1,700	4,966.6	2,353.1	6,719.7
Shore protection, Missouri shore opposite	2,225	3,237.1	1,969.6	5,226.7
Total .....	.....	27,363.5	15,819.7	43,183.2

Excepting a short time in August, 1890, navigation has been reasonably satisfactory, there being never less than 4 feet on the shoalest bars. But as the work of improvement progresses very slowly owing to the limited appropriations, there are so many untouched portions of the river that each year the same difficulties arise. Thus far we have control of the river only at certain places; at many others it remains as it always has, and in these the channel shifts continually and exceedingly. Could there be enough appropriated at once to control stretches like Tully Island, Moziers and Hamburg, Sterling Island, Fritz Island, and others, we might begin to look forward to a possibility of deepening the channel. But until the channel is first reasonably under control no additional depth can be looked for. The items for this district have been so reduced and diverted to points not connected with the general plan of improvement that the net amount available is hardly enough for 1 year's operations, even on a moderate basis. The present appropriation will not allow of any construction by contract work, and only \$100,000 is available for the navigation proper for 2 years. Not less than double the recent appropriations would suffice to carry on this work with efficiency. The fleet of this district has no winter harbor belonging to it, having been wintered heretofore at different places and at unnecessary risk. It needs also a marine railway at least 135 feet long on which to be repaired from time to time. I specifically ask for \$5,000 for this purpose and to purchase or lease a suitable frontage somewhere for harbor purposes.

Money statement.

July 1, 1890, balance unexpended	\$25, 142. 00
Amount appropriated by act approved September 19, 1890	165, 000. 00
	<hr/>
June 30, 1891, amount expended during fiscal year	190, 142. 00
	68, 801. 09
	<hr/>
July 1, 1891, balance unexpended	121, 340. 91
July 1, 1891, outstanding liabilities	\$6, 694. 77
July 1, 1891, amount covered by uncompleted contracts	27, 507. 64
	<hr/>
	34, 202. 41
	<hr/>
July 1, 1891, balance available	87, 138. 50
	<hr/>
{ Amount (estimated) required for completion of existing project	Unknown.
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	300, 000. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Very respectfully, your obedient servant,

E. H. RUFFNER,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REOPENING WILLOW SLOUGH, OR SOME OTHER CHANNEL, FROM
MISSISSIPPI RIVER TO QUINCY BAY, ILLINOIS.

[Printed in House Ex. Doc. No. 284, Fifty-first Congress, second session.]

ENGINEER OFFICE, U. S. ARMY,
Quincy, Ill., December 23, 1890.

GENERAL: I respectfully forward herewith, through the Division Engineer, my report on the examination of Willow Slough as required by the river and harbor act of 1890, accompanied by the following papers:*

Plan of Willow Slough and direct canal.
Sheet of profiles of the same.
Fourteen sheets of cross sections.
Printed sheet, general map, sheet 2.
Blue print, Quincy Bay, showing dredging 1881.
Tracing, Quincy Bay, showing dredging 1885.

Please see my project of operations in regard to this project.

Very respectfully, your obedient servant,

E. H. RUFFNER,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., December 29, 1890.

Respectfully forwarded.

I have made an examination of Willow Slough and Quincy Bay and I not only concur in the conclusion reached by Major Ruffner, but am,

* Not printed.

more strongly than he is, of the opinion that the effect of opening Willow Slough would be detrimental to Quincy Bay for all purposes connected with navigation. It probably would be advantageous to other interests which, as I understand it, we are not called upon to consider.

O. M. POE,
*Colonel, Corps of Engineers,
Division Engineer, Northwest Division.*

REPORT OF MAJOR E. H. RUFFNER, CORPS OF ENGINEERS.

ENGINEER OFFICE, U. S. ARMY,
Quincy, Ill., December 23, 1890.

GENERAL: I respectfully report the following in regard to the examination as "to the advisability of reopening Willow Slough, or some other channel, from the Mississippi River to Quincy Bay," required by the river and harbor act of 1890.

Willow Slough is a low, flat slough, $2\frac{3}{4}$ miles long, connecting the Mississippi River with Quincy Bay when the gauge reads about 5 feet above low-water mark.

The upper end lies behind a large island, No. 422 on our maps, and three-quarters of a mile east of the main channel, which is to the west of Island 422. The chute or slough from which Willow Slough starts is some $8\frac{1}{2}$ miles long, and its upper entrances are closed by dams across Canton and Smoot chutes, built in 1881 and raised and repaired in 1889. A series of wing dams, proposed many years ago, will be built in 1891 from the Illinois shore in the first mile below the foot of Island 422.

These dams, three in number, will cause large deposits of sand above and below them, and at low stages the river near the Illinois shore for $1\frac{1}{4}$ miles below the head of Willow Slough will not be navigable even for very small crafts. Indeed this is already the case from the action of the two dams already built. The slough has a slightly devious course through the wooded, alluvial bottom, that is overflowed at high water, and not necessarily extreme high water. It has been overflowed partly or entirely for longer or shorter periods during 9 of the past 12 years. The mouth of the slough is in Quincy Bay, about 1,000 feet above the harbor as recently established and about 9,350 feet or 1.8 miles above the mouth of the bay. It is owned throughout by private parties, and the ground under the bay is also owned by private parties, from the mouth of the slough to the harbor lines.

A survey of Willow Slough was made in November, 1890, by Assistant Engineer George Wolcott. This survey shows the course of the slough, the profile, and cross sections of the ground taken often enough to give the leading characteristics and to enable a reasonably accurate estimate to be made of the quantity of material to be removed in case the slough should be "reopened," in the language of the act. The plat, profile, and 8 sheets of cross sections are forwarded with this report. A table showing all the data of the survey and the calculated amounts of excavation required to open Willow Slough to a depth of 6 feet at low water, 100 feet wide and with side slopes of 2 horizontal to 1 vertical, will now be given:

2126 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Detailed estimate of Willow Slough survey between Quincy Bay and the Mississippi River.

No. of station.	Distance from station zero.	Elevation above low-water mark, Quincy Bay.	Area of cross-section taken at station.	Volume of prism between stations.	No. of station.	Distance from station zero.	Elevation above low-water mark, Quincy Bay.	Area of cross-section taken at station.	Volume of prism between stations.
	<i>Feet.</i>	<i>Feet.</i>	<i>Sq. feet.</i>	<i>Cubic yds.</i>		<i>Feet.</i>	<i>Feet.</i>	<i>Sq. feet.</i>	<i>Cubic yds.</i>
1	.....	2.948	1,217.50	*1,127.314	72	7,200	6.074	1,768.19	12,667.074
2	200	2.616	1,267.47	9,203.592	75	7,500	5.884	1,721.62	19,332.277
4	400	2.296	1,134.64	8,896.703	76	7,600	5.594	1,732.57	6,896.648
6	600	3.081	1,231.78	8,764.518	77	7,700	8.776	1,655.78	6,274.722
8	800	3.979	1,325.65	9,471.963	78	7,800	9.420	1,692.75	6,200.981
0	1,000	6.812	1,585.71	10,782.814	79	7,900	9.690	1,682.96	6,251.814
12	1,200	5.783	1,620.77	11,875.851	82	8,200	7.347	1,712.58	18,864.111
14	1,400	6.610	1,405.69	11,209.111	84	8,400	6.647	1,718.10	12,706.222
16	1,600	4.465	1,134.85	9,409.407	88	8,800	8.604	1,955.93	27,215.037
18	1,800	4.749	1,287.00	8,969.814	90	9,000	7.143	1,814.49	13,964.518
20	2,000	4.376	1,359.46	9,801.703	91	9,100	8.253	1,625.24	6,369.870
22	2,200	4.420	1,450.72	10,468.074	92	9,200	10.893	1,171.04	6,239.407
24	2,400	4.802	1,472.14	10,825.407	96	9,600	9.346	1,820.56	26,604.444
26	2,600	5.427	1,386.62	10,588.000	100	10,000	7.232	1,973.20	28,101.925
28	2,800	7.567	1,538.38	10,833.703	104	10,400	6.523	1,899.83	28,689.111
32	3,200	7.105	1,535.84	22,772.000	106+75	10,675	7.478	1,783.96	18,760.004
34	3,400	7.555	1,467.05	11,121.814	109	10,900	8.046	1,902.20	15,359.000
36	3,600	6.672	1,492.39	10,960.888	112	11,200	7.690	1,924.32	21,258.500
37	3,700	6.195	1,479.36	5,503.240	114	11,400	7.793	2,043.78	14,690.629
38	3,800	6.785	1,548.80	5,607.703	116	11,600	5.200	1,821.68	14,316.444
42	4,200	9.421	1,688.85	23,982.592	117	11,700	9.250	1,983.20	6,952.481
44	4,400	7.716	1,556.01	12,018.000	121	12,100	7.314	1,960.70	28,843.703
46	4,600	4.556	1,614.90	11,744.111	124	12,400	6.888	1,995.45	21,978.611
48	4,800	8.886	1,615.09	11,962.925	128	12,800	7.155	2,033.87	29,346.814
50	5,000	4.861	1,476.91	11,451.851	132	13,200	7.872	1,835.90	28,664.962
52	5,200	7.559	1,541.67	11,179.925	136	13,600	9.577	1,951.50	28,054.810
56	5,600	7.790	1,737.16	24,287.629	140	14,000	7.402	1,907.23	28,583.185
58	5,800	8.799	1,604.30	12,375.777	144	14,400	7.305	1,981.73	28,807.111
60	6,000	6.226	1,629.50	11,977.037	145+80	14,580	5.737	1,342.63	11,061.200
62	6,200	5.573	1,549.40	11,773.703	145+90	14,590	5.107	981.12	430.324
65	6,500	5.192	1,578.14	17,375.222	146+40	14,640	.....	.....	*875.991
67	6,700	5.954	1,553.53	11,598.777					
70	7,000	7.354	1,667.32	17,893.611					
					Total number cubic yards.....				
					912,213.209				

* This shows the number of yards necessary to complete the work out to 6 feet below low-water mark.—GEO. WOLOTT, Assistant Engineer.

An analysis of the results of this survey shows that, if the water were allowed to flow through an artificial channel of the proposed dimensions and 6 feet in depth, the resultant velocity would be 1.77 miles per hour, which being sufficient to move small gravel, the channel would fill up from erosion, unless the bottom and sides were protected. In this region riprap stone makes the cheapest protection and the estimate is based thereon.

It may be said that if any doubt arises as to the probability of Willow Slough filling up from erosion one has only to think that it *has* filled from natural causes, even if it ever was more open than it is now (which I doubt).

Riprap would probably average about 6 inches in depth, and could be put in place at about \$1 a cubic yard. With these elements the protection of 14,640 feet of canal, with a wetted perimeter, averaging not less than 175 feet, would require about 45,384 cubic yards at \$1 per yard. We have never had dredging done in Quincy Bay at less than 14 cents per cubic yard, and including the removal of the trees and roots, it is quite safe to say that not less than 14 cents should be the estimated cost of dredging.

The cost of reopening Willow Slough would then be as follows:

Dredging 912,213 cubic yards, at 14 cents	\$127, 709. 82
Riprap, 45,384 cubic yards, at \$1	45, 384. 00
	<hr/> 173, 093. 82
Adding 10 per cent. for contingencies and engineering.....	17, 309. 38
	<hr/> 190, 403. 20

We have for the total cost.....

It is quite true that a canal could be estimated for, much smaller in dimensions than this; it could be estimated at half the width (though such a channel could be used only as an aqueduct) and it need not be dug so deep, though the low-water season is the time when a flow of water is desired in Quincy Bay. I have no doubt that a canal could be planned that would require not more than half the amount of dredging estimated, though the riprap could not be reduced in amount more than one-fourth, since there would always be a time in any flood that there would be at least 6 feet of water passing down the canal, and then there would be erosion unless riprap were used. A modified estimate might be made that would reopen Willow Slough enough to allow some water to flow down it at lowest stages, as follows:

Dredging, one-half of prior estimate.....	\$63, 854. 90
Riprap, three-fourths of prior estimate	34, 038. 00
	<hr/> 97, 892. 90
Add 10 per cent. for contingencies.....	9, 789. 29
	<hr/> 107, 682. 19

If we take Rankine's formula, p. 678, and sec. 451, p. 687, $i = \frac{h}{l}$ in this

case $\frac{2'.16}{14.590} = .0001480$. A = area proposed canal = 672 square feet;

$b = 126'.83$; $m = \frac{A}{b} = 5'.298$ hydraulic mean depth; $V' = 92.26 \sqrt{im} = 2'.583$ feet per sec. approx. $V = 2'.6$ feet per sec. = 1.77 miles per hour, or will wash small gravel, say all authorities. This calculation is equally true whatever be the bed of the slough, provided there is 6 feet of water in it, and of course the rises in the river will always secure some such current at some time or other, canal or no canal.

The gauge records at Quincy show that the river has been at and above 5 feet on the gauge, at which stage water begins to flow into Quincy Bay from the river down Willow slough, as it is now, as follows:

	Days.		Days.
1879	62	1885	242
1880	148	1886	156
1881	279	1887	147
1882	214	1888	167
1883	208	1889	71
1884	203	1890	86

Average, 165 per year.

As there is an apparent cycle of high and low water years, which is now in a low-water period, there is every reason to think that a change is approaching which will for some years increase the number of days when there will be a current down the Slough from the river into the bay from natural causes. Thus far attention has been confined to the facts about Willow Slough.

It now becomes necessary to provide for "some other channel" than

Willow Slough, in the language of the act. An examination of the map of the river in the vicinity of Quincy (a copy of which is inclosed) will show that when the works of improvement contemplated for the vicinity of Cottonwood Island are completed the channel of the river will follow the Illinois shore, as it does now, opposite Upper Cottonwood Island, and it then leaves the Illinois shore for the Missouri shore, as governed by a dike constructed by the bridge company 24 years ago.

In order that a canal from the river to the bay should always have water at its river end without dredging it should be located somewhere in this stretch of a mile, and in order to have the least possible dredging done the line should be the shortest which would carry it to the lower end.

The bay end of such a canal should be near the upper end of the established harbor lines of Quincy Bay, or at least not above that point.

Such a line has been surveyed by Mr. George Wolcott in a similar manner to that of Willow Slough, and the same data are collected and exhibited, and the same character of a canal contemplated. No shorter or less expensive line could be located, if any regard be had to navigation, and I assume that it is supposed that the United States will not embark in an undertaking of the kind unless water craft can use the canal at some time. The following table gives all information necessary:

Detailed estimate of direct channel survey between Quincy Bay and the Mississippi River.

No. of station.	Distance from station zero.	Elevation above low-water mark, Quincy Bay.	Area of cross section taken at station.	Volume of prism between stations.	No. of station.	Distance from station zero.	Elevation above low-water mark, Quincy Bay.	Area of cross section taken at station.	Volume of prism between stations.
	Feet.	Feet.	Sq. feet.	Cu. yards.		Feet.	Feet.	Sq. feet.	Cu. yards.
0.....	200	11.157	2,069.10	11,821.77	30.....	3,000	10.885	2,124.05	20,315.34
2.....	200	11.157	2,069.10	11,821.77	34.....	3,400	11.163	2,116.81	31,413.60
6.....	600	12.013	2,612.61	34,827.48	34+20.....	3,420	2.808	2,427.45	1,683.04
8+60.....	860	11.613	2,382.61	24,050.94	34+50.....	3,450	2.588	2,265.50	2,607.18
9.....	900	6.793	1,595.85	2,947.00	35.....	3,500	7.538	1,621.60	3,569.15
11+20.....	1,120	12.392	2,462.30	16,533.16	36.....	3,600	10.488	1,890.72	6,485.77
11+40.....	1,140	8.532	1,850.45	1,600.64	38.....	3,800	12.148	2,197.71	15,105.29
12.....	1,200	8.331	1,835.81	4,105.84	40.....	4,000	9.311	1,848.63	14,986.44
13.....	1,300	2.332	928.00	5,118.10	42.....	4,200	10.891	2,123.28	14,710.68
13+80.....	1,380	3.632	1,102.98	3,008.80	42+50.....	4,250	6.678	1,159.54	3,317.40
14+10.....	1,410	13.772	2,694.80	2,109.87	43.....	4,300	11.998	2,291.67	3,472.30
15+50.....	1,550	7.972	1,437.95	10,714.48	44+35.....	4,435	7.978	1,698.80	9,976.09
16+40.....	1,640	14.142	2,755.66	6,989.31	44+50.....	4,450	14.978	2,603.80	1,195.15
17+50.....	1,750	8.002	1,774.37	9,228.23	48.....	4,800	9.074	1,842.41	28,817.95
19+50.....	1,950	10.843	2,217.00	14,783.40	48+80.....	4,880	13.494	2,373.92	6,246.40
19+80.....	1,980	5.363	1,331.80	1,971.54	49+35.....	4,935	13.006	2,290.24	4,750.51
23+85.....	2,385	7.504	1,638.04	22,273.78	49+65.....	4,965	3.441	967.78	1,809.99
24.....	2,400	9.909	2,123.03	1,044.73	50+25.....	5,025			973.24
24+75.....	2,475	10.829	2,146.76	5,930.25					
26+20.....	2,620	2.379	905.92	8,196.90					
27+30.....	2,730	9.399	1,939.06	5,795.24					
					Total number cubic yards.....				
					364,871.61				

* This shows the number of yards necessary to complete the work out to 6 feet below low-water mark.—GEO. WOLCOTT, Assistant Engineer.

The estimated cost of such a canal, based upon prior calculations, would be:

Dredging 364,871 cubic yards, at 14 cents.....	\$51,081.94
Riprap, 15,391 cubic yards, at \$1.....	15,391.00
	66,472.94
Add 10 per cent. for contingencies.....	6,647.29
Total.....	73,120.23

Similar calculation as to the elements of such a canal gives—

$$i = \frac{h}{l} = \frac{1'.14}{4965} = .0002296$$

$A = \text{area} = 672$ square feet.

$b = \text{border} = 126'.83$ for depth of 6 feet of water.

$\frac{A}{b} = m = 5'.298$ hydraulic mean depth.

$$f' = .007565 \quad v' = 92.26 \sqrt{im} = 3'.2181.$$

$$v = \left(\frac{3}{2} - \frac{f'}{.01513} \right) v' = 3'.218 \text{ feet per second.}$$

This velocity is equal to 2.23 miles per hour, and will move pebbles as large as an egg. Discharge will be about 2,200 cubic feet per second, or somewhat more than a tenth of the low-water discharge of the river at Quincy. If the canal were only 50 feet wide at the bottom the velocity would still be 3'.128 per second, or 2.13 miles per hour.

When the river rose to 6 feet on the gauge, and there would be 12 feet in the canal, the velocity would be 4'.381 per second, or 3 miles per hour. The same would occur at 12 feet on the gauge if there were only a canal 12 feet deep; that is, only to low-water mark. This velocity is that recorded at Hannibal, when the gauge read 12 feet and the discharge was 140,000 cubic feet per second. This question of velocity is the most important item in the project and should be thoroughly understood. Since Quincy Bay has no connection with the river from the upper end at low stages it has a level water surface and no slope. The average slope of the river is, however, about 6 inches to the mile, and the higher up the river we go and the shorter line we run to Quincy Bay the greater slope we have and the greater velocity. To any one familiar with the velocity of the river above and through Quincy Bridge to the City Wharf a proposition to concentrate the fall of this distance, which is somewhat less than $2\frac{1}{2}$ miles by the channel, into a short canal of less than a mile, would be viewed with some distrust. If the concentration of the canal could be preserved through Quincy Bay the case would be different.

But the outcome is a wide, flat, shallow surface, not less than 350 feet wide at the low-water mark in narrow parts of the bay, and widening rapidly with the rise of water. There would be then under the most favorable conditions high velocity in the canal and much less in the bay a short distance below the mouth. In short, the proposition involves all the considerations due to a "cut-off;" that is, leading a part of a great river through a short line instead of a much longer one.

Let us now consider some points in reference to the navigability of the proposed canal. The distance by the river channel from the head of the canal to Quincy Wharf, passing through the Quincy Bridge, with its draw of 160 feet opening, is about 12,800 feet. The distance between the same points passing down the canal, through the 70-foot draw span of the Bay Bridge, is about 14,847 feet, a clear loss of about 2,000 feet. To be sure, rafts and small craft having business in Quincy Bay would go down the canal, but few boats would attempt to go up it. There would be a constant suction down the canal, at the head, which would be a source of anxiety to pilots passing down the main channel and not intending to use the canal. This suction would be of very great importance, and a source of danger when the ice breaks up in the spring.

One very great advantage that Quincy Bay now possesses is that it is a secure ice-harbor, or winter harbor, for boats. With an open canal

leading down from the river into the bay, we may foretell what might happen at the end of a severe winter. The bay, canal, and river will be frozen, as they frequently are, with ice 15 inches thick or more. A thaw comes on a rising river, and this heavy mass is raised from its side anchorages, is broken to pieces and driven down the bay, is piled up against the piers of the Bay Bridge, and then when enough head is gained and the whole is somewhat softened it gives way, crashing down the bay, carrying with it all frail vessels, until a mass large enough is accumulated to tear away all steamboats that have sought Quincy Bay as a safe winter harbor, such as it is now.

This is not a fancy picture. Ice has been forced in times past down Squaw Chute, a short small slough, into Quincy Bay, at the lower end, when a break-up occurred at a stage suitable for such an event, and one of our difficulties is to maintain, against the ice, dams that we build to close up just such small sloughs as is here proposed to be opened.

Let us now consider the engineering propositions of the project. The general plan of improvement of this river proposes to close all small useless island chutes and sloughs. The plan of concentration requires the constant passage down the main low-water bed of the river of the bulk of the water.

For 12 years we have made a practice of closing such small chutes. The maps show how many have been closed, and the testimony is unanimous that such closure is in the interest of navigation.

Three such closures have been made in sight of Quincy, and one small slough running into the bay has itself been closed, Squaw Chute by name. It does not need argument at this time to show that this plan is the proper one to follow. Yet the opening of Willow Slough or some other channel from the Mississippi River into Quincy Bay will be a direct violation of this practice.

What engineering reason has been assigned why this canal should be dug? The only one that has come to my knowledge has been that the current introduced into Quincy Bay would scour out the bar at the mouth of Whipple and Cedar creeks, and in general keep the bay from filling up. I have already shown that there would undoubtedly be a great diminution of velocity and scouring effect after the water of the canal reached Quincy Bay.

There is no doubt that the canal would scour a canal or channel equal in capacity to itself through Whipple Creek Bar. The matter so scoured would deposit lower down in the bay, and eventually a channel equal in capacity to the dug canal would be scoured and maintained through the lower bay. That is the limit of capacity of the current introduced into Quincy Bay, to scour and maintain a channel equal to itself. *But we have such a channel* already in Quincy Bay, and *greater* throughout, except through Whipple and Cedar Creek Bar, and this has been half opened, and will be entirely opened by July 1, probably at an expense of not over \$6,000. In point of fact, the total expense of maintaining by dredging the harbor of Quincy Bay for 11 years has been only \$66,300, instead of the minimum amount of \$73,120, proposed in this project to secure a smaller channel with many disadvantages.

Of the work already done in Quincy Bay about \$20,000 worth of damage was caused by the flood of 1888, during which the Indian Grave levee broke at the head of the bay, and a large amount of material was precipitated into the bay, entirely filling up the channel dug through Whipple Creek Bar in 1884 and 1885, and the areas just below that bar. There is now available for dredging in Quincy Bay \$25,000. This money will be spent in carrying out the project of 1879, and there is no

doubt in my mind that it will suffice to widen and deepen the channel throughout Quincy Bay enough to answer all purposes, and secure the necessary area and depth within the harbor lines for all the purposes of navigation for not less than 6 years. Maps showing the areas dredged at various times in Quincy Bay are inclosed herewith.*

The dredging proposed in 1885 was done that year, and two cuts, 60 feet in width in all, were dug through the same in 1889 and 1890, and on the same lines the contractors will operate in 1891 and 1892.

To conclude, I do not think it advisable to reopen Willow Slough or any other channel from the Mississippi River to Quincy Bay, for the following reasons:

(1) It is contrary to the theory of the improvement of this river, as adopted by the United States.

(2) No use could be made of such canal by navigation that is not already better provided for.

(3) Such a canal would endanger the safety of crafts using Quincy Bay as an ice or winter harbor.

(4) It is needless, because the only value to be got from its construction is easier and cheaper secured by dredging.

I am, sir, very respectfully, your obedient servant,

E. H. RUFFNER,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF BOARD OF ENGINEERS.

ENGINEER OFFICE, U. S. ARMY,
Quincy, Ill., February 18, 1891.

GENERAL: The Board of Engineers constituted by paragraph 1, Special Orders, No. 77, Headquarters Corps of Engineers, November 7, 1890, to which was assigned by indorsement by the Chief of Engineers dated January 2, 1891, the consideration of the report on examination for purpose of reopening Willow Slough or some other channel from Mississippi River to Quincy Bay, submits the following report:

Pursuant to the call of the senior member the Board met in Quincy on February 17, and held a public meeting, where the views and wishes of all persons interested were invited to be expressed. As due notice had been given the city authorities by letter, and the public by notices published in the daily morning and evening papers, there was a full attendance at this meeting of those most interested in and cognizant of the matter in question. There is inclosed a brief résumé of the speeches and remarks made by parties at the meeting. Two sessions were held, morning and afternoon. The only written documents submitted to the Board are a paper of the city engineer, Mr. E. R. Chatten, calling the attention of the city council to the danger of allowing certain intended sewers to empty into Quincy Bay, and a paper signed by numerous parties asking that a channel be opened from the river to the bay, and that a small levee be built on Whipple and Cedar Creek Bar to catch therein the deposits of these creeks and prevent them entering the bay.

It may be said, therefore, that the Board is quite well informed as to the wishes of all concerned.

* Not printed.

The Board considers that Major Ruffner's detailed report, which gives all the facts bearing upon the question and detailed estimates of cost, covers all the points that need be discussed and adopts it as a part of this report.

It appears that formerly there was a current in Quincy Bay at lower stages than at present, but that, by the construction of the Indian Grave levee, certain movements of sand bars in the Mississippi River, and the filling up of Willow Slough, such current has been virtually destroyed at all stages of less than 5 feet at low water. This absence of current at low stages of the river affects the purity of the water in the bay and to a certain extent results in the deposit of a limited amount of the material brought in by creeks. By slightly deepening Willow Slough, or other practicable means, the length of time during which fresh water can reach the bay may be prolonged, and such a result is probably very desirable on sanitary grounds, but to furnish a channel which will serve the purpose of navigation or permit the passage of a sufficient amount of water to have any effect on the deposits in the bay is a work which would be very expensive and which the interests of commerce do not appear to justify.

The Board would respectfully state that in their opinion the "re-opening of Willow Slough or some other channel from the Mississippi to Quincy Bay" is not advisable.

A. MACKENZIE,
Major, Corps of Engineers.
A. M. MILLER,
Major, Corps of Engineers.
E. H. RUFFNER,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

MINUTES OF PUBLIC MEETING.

ENGINEER OFFICE, U. S. ARMY,
Quincy, Ill.

Report of the meeting held at the Y. M. B. A. rooms February 17, 1891, in regard to opening Willow Slough or some other channel into Quincy Bay.

After an explanation of the object of the meeting by Major Ruffner, City Engineer Chatten stated that through the closure of channels from the river caused the water to stagnate, and that a channel would be very important to carry off the deposit.

C. D. Van Frank then read a petition in regard to the building of a levee around the mouth of Cedar Creek to prevent deposit in the bay.

F. W. Meyer was called upon, and stated that by the building of levees the supply of water was cut off from the bay, and through that source the bay has been gradually filling, and river and ice men especially have been damaged to a great extent. Thinks that by opening a channel a current into the bay will prevent all further deposit at its mouth.

George A. Anderson: In regard to the advantages of a channel in Quincy Bay and its importance to navigation.

C. D. Van Frank stated that a channel in the upper part of the bay would be a most desirable thing; it would form a continual current through the bay without washing its banks and without the least danger to steamboats; would form a most excellent harbor.

Col. W. W. Berry: In regard to the navigability of Quincy Bay and the importance of a channel.

C. D. Van Frank stated that a channel such as proposed would carry all the deposit sewage from the bay and have force enough to carry out what is materially deposited there. Thinks there would be very little expense connected with the repair of such channel. There should be a channel running into the bay at low stages to prevent filling in at the lower end.

J. D. Morgan: In regard to the changes in the river that have taken place under his observations since landing here 56 years ago.

Louis Boswell: It seems to me that considerable discussion has been carried on in regard to a channel into Quincy Bay. I do not desire to speak of what would seem like telling a workman his own business, nor would I tell him to carry out what I thought was the right thing. The Quincy Bay is a navigable stream, dependent somewhat upon the water course; formerly it was without difficulty that loads of iron and lumber were taken up the bay, but of late years we have had to abandon it. Besides the interest such as the property owners have, there is at present interest felt for this stream as navigable water.

The Government engineers work upon their judgment as to the best means of carrying out things to the best of their knowledge for the benefit of the people; we must rely upon their judgment. Let us ask them not to think this a private scheme.

The Quincy Bay should be maintained as a navigable stream. The sanitary condition of the water is of minor importance to a growing city, although the lives of 125 men are practically endangered by its use. If the Government will make the stream navigable, it will bring commerce into it and enable us to reach our factories. The bay should be opened not as a private but as a national interest.

Captain Brown states that by the building of the bridge and disturbing the land has had some effect in filling up of the bay. Does not think that a rapid current in the bay will maintain it as a navigable stream; that it must be dredged even once a year.

James Woodruff: In regard to navigability and advantages of a channel into Quincy Bay and the unhealthy condition of the water.

George A. Anderson: In regard to suitability of Quincy Bay for commerce. Does not think that dredging alone will make the bay suitable for navigation.

H. F. J. Ricker stated that he remembers when Wood and Willow sloughs afforded good ice harvests, and in the spring were used by woodmen; but in the last 5 or 10 years have filled up so fast that the natural course of water from the river has been shut off.

F. M. Collins: In regard to the navigability of Quincy Bay and the advantages of a channel from the river.

Ed. Wells states that in order to prevent the bay from filling in dredging will have to be resorted to often, and that a channel should be cut through from the river to keep it open.

Ed. Seeger stated that Mr. Van Frank's ideas in regard to this very important channel at the upper end of the bay to form a continual current are very good.

The meeting then adjourned until 2 p. m., but nothing of importance came up.

LETTER OF MR. E. R. CHATTEN, CITY ENGINEER.

QUINCY, ILL., November 30, 1889.

GENTLEMEN: In the matter of a proposed change in the second district of the sewage system referred to me, I would respectfully report that any change in the system would increase the cost, as additional rock excavation would be necessary to cross and use private property to secure the drainage, owing to the fact that the fall from Cedar and Front to Broadway and Front is so slight as to make it difficult to dispose of sewage. To change system so as to bring sewer from a point at north end of second district to place of delivery would necessitate a choice of two routes, viz: either along the bay or along Front street to cattle yards, and then along the bay to the point of delivery; sooner or later, as the city grows in size and population, the bay will have to be used as an outlet for sewage, as it is now by Soldiers' Home, and before any change is made in the present system I would respectfully suggest that the matter be given a careful investigation with a view to the possibility of obtaining a continuous current through the bay, which would effectually remedy the causes for complaint against the present system.

Any practicable change will add from \$15,000 to \$20,000 to the cost, approximately, and if the plan proposed by Mr. Van Frank were adopted it would deprive, to a great extent, the northern portion of the city of the benefits of sewerage, as it would be inaccessible from points north of sewer, owing to the ravine which lies between those points.

The expense of that plan would be much greater than any other, as excavation would be greater. The opinion given as to cost, fall, etc., is based upon the figures given in plat of system and grade books, but in order to make accurate figures a complete survey of that district should be made.

Respectfully submitted.

E. R. CHATTEN,
City Engineer.

To the honorable MAYOR AND CITY COUNCIL.

PETITION OF CITIZENS OF QUINCY, ILLINOIS.

QUINCY, ILL., *February 17, 1891.*

GENTLEMEN: In the matter of opening a channel from Mississippi River to Quincy Bay:

Such a channel seems every way desirable for the purposes of navigation.

To get the best results from such improvement of Quincy Harbor it seems to us that the proposed channel should leave the river at some point above the railroad bridge where the steamboat channel of river sets in to the Illinois shore, thence across the island in a direct line to some point in the bay near to the northern limits of harbor, and such channel should be broad and deep enough to admit steamboats at all stages of river; the sides and bottom should be properly protected by riprap to prevent scouring.

Such a channel would not only make a good and desirable inlet for steamboats and other crafts to the upper end of Quincy Harbor, but would also supply a current which would carry out a large percentage of the material now depositing in the bay.

In connection with the above it seems to us that instead of removing the main part of Whipple or Cedar Creek Bar, which will be a very expensive undertaking, will it not be more economical and advantageous, and also answer all the requirements of navigation, to open a good navigable channel along the western part of said bay, and then build a levee around the remaining part of the bar with suitable water ways for the escape of the water of Cedar Creek, such levee to hold the deposits of the creeks on shore, thus preventing further injury to navigation from that source.

C. D. VAN FRANK
(and 33 others).

BOARD OF ENGINEER OFFICERS,
CONSIDERING QUINCY BAY IMPROVEMENTS.

Z 2.

PRELIMINARY EXAMINATION OF MISSISSIPPI RIVER AT WARSAW, ILLINOIS, WITH A VIEW OF REMOVING BAR.

[Printed in House Ex. Doc. No. 6, Fifty-First Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 4, 1890.

SIR: I have the honor to submit herewith the accompanying copy of report dated October 29, 1890, from Maj. E. H. Ruffner, Corps of Engineers, giving results of the preliminary examination of Mississippi River at Warsaw, Ill., with a view of removing bar, made to comply with provisions of the river and harbor act approved September 19, 1890.

Major Ruffner reports that he does not consider this section of the river worthy of improvement, and on the contrary that the removal of the bar would be a detriment to navigation. Col. O. M. Poe, Corps of Engineers, agrees that the locality should not be improved by the General Government, and in this opinion I concur.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF MAJOR E. H. RUFFNER, CORPS OF ENGINEERS.

ENGINEER OFFICE, UNITED STATES ARMY,
Quincy, Ill., October 29, 1890.

GENERAL: In obedience to letter of instructions of the 20th September, I have the honor to render the following report of a preliminary examination of Mississippi River at Warsaw, Ill., with a view to removing bar, as required by the river and harbor act of September 19, 1890.

A personal examination of the river near the public steamboat landing at Warsaw, Ill., and conversation with pilots who know the river, confirmed my prior knowledge that there was no bar in front of or near the public landing at Warsaw. There has been no bar near or interfering with this landing for some years, and there is no bar approaching or coming down on it. In order to ascertain exactly what was the intention of the act, the steamer *Success* was subsequently stopped at Warsaw and a search made by Assistant Engineer Richards and Pilot Ames for parties knowing anything about the matter. It was then discovered that the clause was inserted at the request of the owners of a woolen mill some two-thirds of a mile below the public landing. There is a large sand bar in front of this mill, and on account of low water there had been a necessity for extending the supply pipe for the boilers into the river. The nature of well water at the mill site was such that the boilers could not advantageously use that well water, and therefore as the bar grew in size from year to year, it became necessary to extend the supply pipe to the river, until finally some 1,700 feet of pipe in all were laid. This long pipe would not be required if the bar were removed, and hence the suggestion as to an inquiry in reference to the cost of removing this bar.

Steamboats are not enabled to land at or near the mill, and any goods shipped by steamboat must be hauled in wagons over the two-thirds of a mile to the steamboat landing. I did not understand that it was considered desirable that the bar should be removed in order to allow steamboats to land at the mill, nor do I understand that the mill makes many shipments by water. It will now be best to consider the engineering features of the situation. A tracing of the general map of the vicinity of Warsaw is inclosed.* This shows the outlines of the low-water bed of the river as it will be when completely regulated at this stretch. The broken lines show a width of about 1,400 feet (some 400 feet less than in other localities), and the two wing dams on the Missouri shore, built in 1880, and one raised in 1887, hold the body of water on the Illinois shore at the Warsaw Landing. The current and body of water then leave the Illinois shore and go over to the Missouri shore and the Alexandria Landing. This set of the current is much more marked at high water than at low water, and the head of Fox Island and Alexandria Point can be held only by revetment, as shown. This state of affairs produces an eddy under the lee of Warsaw Point, and the large bar shown is the result. I presume that bar has always been there, and certainly as a result of our works of permanent contraction it not only will always be there, but probably will increase in height and maintain a width at low stages of about what it is now, *i. e.*, about as far as the broken lines or channel lines show, at least 1,400 feet in a straight line from the mill in question. If it happen at the present time to be a little wider than that, possibly the next high water will

* Not reprinted.

wash off some of the extra width. We consider the condition of the river for the 2 miles in distance from the upper part of Warsaw to the middle of Fox Island as very favorable.

In consideration, therefore, of the whole, I respectfully report that I do not consider the removal of the bar below Warsaw, Ill., as worthy of improvement, but, on the contrary, that its removal would be a positive detriment to that portion of the navigable river.

Very respectfully, your obedient servant,

E. H. RUFFNER,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer,
Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., November 1, 1890.

Respectfully forwarded.

I concur in the opinion of the district engineer that, under present conditions, the "Mississippi River at Warsaw, Ill., with a view to removing bar," is not worthy of improvement by the General Government.

O. M. POE,
*Colonel, Corps of Engineers,
Division Engineer, Northwest Division.*

APPENDIX A A.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MINNEAPOLIS AND DES MOINES RAPIDS, AND OF DES MOINES RAPIDS; OPERATING AND CARE OF DES MOINES RAPIDS CANAL AND DRY DOCK.

REPORT OF MAJOR A. MACKENZIE, CORPS OF ENGINEERS, OFFICER IN
CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER
DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|---|---|
| 1. Operating snag boats and dredge boats
on Upper Mississippi River. | 3. Des Moines Rapids, Mississippi River. |
| 2. Mississippi River between Minneapolis
and Des Moines Rapids. | 4. Operating and care of Des Moines Rap-
ids Canal and Dry Dock. |

EXAMINATIONS AND SURVEYS.

- | | |
|---|--|
| 5. Slough at Hamilton, Illinois, with a
view of dredging out the same. | 6. Mississippi River at and above Clinton,
Iowa, with view of removing
bars north of Little Rock Island. |
|---|--|

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 9, 1891.

GENERAL: I have the honor to transmit herewith the annual reports
upon the works in my charge during the fiscal year ending June 30,
1891.

Very respectfully, your obedient servant,

A. MACKENZIE,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

A A 1.

OPERATING SNAG BOATS AND DREDGE BOATS ON UPPER MISSISSIPPI RIVER.

The work covered by this appropriation is the removal of snags,
wrecks, and other obstructions, the cutting and pulling back of over-
hanging trees, the clearing of shores, the searching for and marking

of new channels, assisting stranded boats and barges, surveys and examinations in connection with new improvements and for facilitating navigation through bridges, inspection and repair of existing works, formation of temporary or permanent channels through obstructing bars, and in general in benefiting commerce by aiding existing navigation and assisting in the permanent improvement of the Upper Mississippi River.

The plant used in connection with this work is the snag boats and dredges. At times when the plant is not required in connection with this special work it is use under general or special appropriations for work of permanent construction.

By the river and harbor act of August 11, 1888, provision was made for operating snag boats, and dredge boats on the Upper Mississippi River under an indefinite appropriation, the annual expenditure being limited by the act to \$25,000. There has been expended under the indefinite appropriation during the fiscal year ending June 30, 1891, the sum of \$25,000.

The snag boat *General Barnard* was engaged in the work of removing snags, etc., from July 1 to October 10, 1890, and from May 18 to June 30, 1891. During a part of the season of 1890 she was employed in towing dredge *Phoenix* to various points on the river. Dredge *Phoenix* was engaged from July 16 to October 3, 1890, in removing wrecks, cribs, and other obstructions above Keokuk, in which work she was assisted by steam launch *Ada*. The snagboat *J. G. Parke*, having been thoroughly repaired, was put in commission May 10, 1891; and from that time to June 30, 1891, was employed in connection with dredge *Phoenix* and steam launch *Elsie* in deepening the permanent channel at Nininger. The details of work accomplished, together with statistics of commerce and navigation, are given in the appended report of Assistant Engineer C. W. Durham.

A detailed statement and a summary of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1891, are appended.

The total tonnage of the Mississippi River between the Falls of St. Anthony and mouth of Illinois River for calendar year 1890 was approximately 4,400,000 tons. This includes logs and lumber as well as ordinary merchandise.

ABSTRACT OF APPROPRIATIONS.

By act approved March 2, 1867	\$96, 000
By allotment from appropriation of July 25, 1868	26, 000
By allotment from appropriation of 1869	35, 640
By act approved—	
July 11, 1870	36, 000
March 3, 1871	42, 000
June 10, 1872	42, 000
March 3, 1873	25, 000
June 23, 1874	25, 000
March 3, 1875	25, 000
August 14, 1876	30, 000
June 18, 1878	41, 500
March 3, 1879	20, 000
June 14, 1880	8, 000
March 3, 1881	25, 000
By act passed August 2, 1882	25, 000
By act approved August 5, 1886	22, 500
By act of August 11, 1888, for fiscal year ending—	
June 30, 1889	25, 000
June 30, 1890	25, 000
June 30, 1891	25, 000
Total	599, 640

Money statement.

June 30, 1891, amount drawn from Treasury under permanent appropriation	\$25,000
June 30, 1891, amount expended during fiscal year	25,000
July 1, 1891, amount available, under permanent appropriation of August 11, 1888, for fiscal year ending June 30, 1892	25,000

Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1891.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
<i>July, 1890.</i>								
1	George Hill	\$137.21						\$137.21
2	McElroy & Armitage	18.78						18.78
3	P. R. Sutton	12.29						12.29
4	Carson & Rand	21.40						21.40
5	A. Weber & Co	23.30					\$23.30	
6	Wilkinson & Co	84.06						84.06
7	R. S. Owen	9.00						
8	T. Nodler	113.44				\$7.20		
9	do	84.52						
10	Kellogg, Birge & Co	312.81						
11	A. Boschert & Co	86.25						
12	Hy. A. Koettker	27.35						
13	Jno. M. Kelflein	94.50						
14	Ward & Brady	372.86						
15	W. R. Tibbals	125.00						
16	Hired men	1,473.99		\$125.00				
17	do	325.00	\$325.00	1,473.99				
18	Various persons	98.45						
19	W. A. Bonasack	15.90						15.90
20	Hired men	357.75		357.75				
21	Wilkinson & Co	10.80						10.80
22	Hired men	128.45						128.45
23	Raze & Davis	8.75						
24	Charles Munson Belting Co.	13.59						
	Total	3,890.45	325.00	1,956.74	565.00	185.20	438.62	428.89
<i>August, 1890.</i>								
1	Gauntz Bros. & Schwab	28.25			28.25			
2	do	23.55			23.55			
3	Thos. E. Schindler & Co.	24.51			24.51			
4	F. W. Luley & Son	37.52			37.52			
5	Chas. J. Long	32.11			29.61		2.50	
6	Various persons	192.70			16.20	176.50		
7	Henry Harrison	54.00				54.00		
8	T. C. Bright & Co	50.00				50.00		
9	S. G. Garnett	30.00				30.00		
10	James Robinson & Son	30.00				30.00		
11	C. A. Hutchinson	25.50				25.50		
12	C. W. Durham	4.00	4.00					
13	Osgood Dredge Co	26.96						26.96
14	Murray Iron Works Co.	6.50						6.50
15	Ewald Iron Co	5.39						5.39
16	Henry Harrison	54.00				54.00		
17	Chas. J. Long	13.60			13.60			
18	Thos. E. Schindler & Co	22.59			22.59			
19	Simmons Hardware Co	1.20					1.20	
20	McElroy & Armitage	4.20						4.20
21	A. Weber & Co	19.69						19.69
22	Carson & Rand	2.91						2.91
23	H. C. Hodge & Sons	29.39			29.39			
24	Lesch & Ireland	13.20			13.20			
25	H. V. Stolts	8.16			8.16			
26	Pilot Steamboat Co	286.52				286.52		
27	Fred. A. Bill	54.00				54.00		
28	Henry Harrison	47.70				47.70		

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Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River, etc.—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
<i>August, 1890—Continued.</i>								
29	Chas. J. Long	\$43.96			\$37.71		\$6.25	
30	Thos. E. Schindler & Co.	36.79			36.79			
31	J. L. Vanosdoll.	6.98			6.98			
32	L. Harris.	7.00			7.00			
33	William Powers.	10.00				\$10.00		
34	Various persons	71.49			22.49	49.00		
35	Hired men.	1,428.67		\$1,428.67				
36	do	405.00		405.00				
37	Charles Delile	75.00		75.00				
38	James Robinson & Son	109.00				109.00		
39	Gauntz Bros. & Schwab.	51.11			51.11			
40	Hired men	272.79						\$272.79
	Total	3,645.94	\$4.00	1,908.67	408.66	976.22	9.95	338.44
<i>September, 1890.</i>								
1	Albert Kirchner	141.13			63.63	75.00	2.50	
2	Gentzkow Bros	10.79			10.79			
3	John Harry	156.50				156.50		
4	W. Ketcham	95.51				95.51		
5	John Harry	56.25				56.25		
6	S. G. Garnett.	30.00				30.00		
7	Gauntz Bros. & Schwab.	47.38			47.38			
8	F. W. Luley & Son.	26.69			26.69			
9	Gentzkow Bros	15.07			15.07			
10	F. Walter & Son	59.14			57.64		1.50	
11	T. C. Bright & Co	62.50			2.50	60.00		
12	Hired men.	1,448.00		1,448.00				
13	Various persons	52.05			37.05	15.00		
14	William Ryan & Son	16.70			16.70			
	Total	2,217.71		1,448.00	277.45	488.26	4.00	
<i>October, 1890.</i>								
1	Ed. Gilbert	18.00		18.00				
2	E. M. Dickey Co.	36.00				36.00		
3	C. A. Hutchinson.	42.50				42.50		
4	A. M. Riddle	6.63					6.63	
5	Charles J. Long	34.53			34.28		.25	
6	Henry Harrison	45.00				45.00		
7	Thos. E. Schindler & Co.	21.92			21.92			
8	Hired men	125.67		125.67				
9	Ryan Drug Co.	13.66					13.66	
10	Hart & Faabender	78.54			49.26		29.28	
11	Matthew Ahern	2.40			2.40			
12	Shadle and Acker Coal Co	50.60				50.60		
13	M. D. Franklin	10.00				10.00		
14	S. W. Vanderwarker	4.15				4.15		
15	P. W. Hawes	25.50				25.50		
16	Charles E. Rose.	13.50				13.50		
17	Consolidated Coal Co	94.50				94.50		
18	W. A. Bonsack	69.41						69.41
19	James P. Simms & Son	127.50					127.50	
20	Ward & Brady	16.16					16.16	
21	H. A. Koettker	8.55			8.55			
22	R. C. Libbey & Co	7.56					7.56	
23	F. B. Martin	10.25	10.25					
24	C. W. Durham	4.45	4.45					
25	Baker & Housman	5.50						5.50
26	A. Boschert & Co.	10.84			10.84			
27	Kranz & Jahn	36.01			36.01			
28	Hired men	914.49	100.00	814.49				
29	do	154.01						154.01
	Total	1,987.83	114.70	958.16	163.26	321.75	201.04	228.92
<i>November, 1890.</i>								
30	Hired men	415.00	200.00	215.00				

Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River, etc.—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, equipment, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
<i>December, 1890.</i>								
31	William Towle & Co.....	\$47.60						\$47.60
32	Hired men.....	415.00	\$200.00	\$215.00				
33	Ward & Brady.....	3.90						3.90
34	A. Weber & Co.....	3.52						3.52
	Total.....	470.02	200.00	215.00				55.02
<i>January, 1891.</i>								
1	William Towle & Co.....	75.79						75.79
<i>February, 1891.</i>								
2	Samuel C. Westcott.....	3.05	3.05					
3	C. W. Durham.....	13.70	13.70					
4	Hired men.....	415.00	200.00	215.00				
5	W. R. Tibbals.....	4.75	4.75					
6	W. A. Bonaack Lumber Co.....	127.20						127.20
7	Wilkinson & Co.....	40.39						40.39
8	A. Weber & Co.....	36.30						36.30
9	McElroy & Armitage.....	3.96						3.96
10	P. R. Sutton.....	3.04						3.04
11	C. W. Durham.....	11.50	11.50					
12	Hired men.....	415.00	200.00	215.00				
13	Carson & Rand.....	55.25						55.25
14	Hired men.....	655.73						655.73
	Total.....	1,785.47	433.00	430.00				922.47
<i>March, 1891.</i>								
15	W. R. Tibbals.....	125.00		125.00				
16	C. W. Durham.....	12.25	12.25					
17	Taber & Co.....	379.16						379.16
18	Hart. E. Linehan.....	217.50						217.50
19	Wilkinson & Co.....	121.48						121.48
20	McElroy & Armitage.....	29.05						29.05
21	Taber & Co.....	17.95						17.95
22	A. Weber & Co.....	31.33						31.33
23	Vollers & Warttman.....	13.09						13.09
24	Kellogg, Birge & Co.....	8.40						8.40
25	D. Tipton.....	9.00	9.00					
26	Hired men.....	707.00	200.00	215.00				292.00
27	do.....	480.99		125.00				355.99
	Total.....	2,152.20	221.25	465.00				1,465.95
<i>April, 1891.</i>								
1	C. W. Durham.....	12.75	12.75					
2	do.....	13.20	13.20					
3	Jacob Seither.....	92.88						92.88
4	Broderick & Bascom.....	108.68					\$108.68	
5	Clark-Johnson Co.....	197.25						197.25
6	Simmons Hardware Co.....	47.18					47.18	
7	McElroy & Armitage.....	21.39						21.39
8	A. Weber & Co.....	15.80						15.80
9	Wilkinson & Co.....	4.10						4.10
10	Hired men.....	412.74						412.74
11	do.....	670.50		215.00				455.50
12	C. A. Hutchinson.....	64.65						64.65
	Total.....	1,661.10	25.95	215.00			155.86	1,264.29
<i>May, 1891.</i>								
13	E. Mead.....	4.50					4.50	
14	Sullivan & Auwerda.....	11.53					11.53	
15	H. Ridder & Co.....	9.31					9.31	
16	Jacob Seither.....	11.10					11.10	
17	Vollers & Warttman.....	116.58						116.58
18	McElroy & Armitage.....	3.15						3.15

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Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River, etc.—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
<i>May, 1891—Continued.</i>								
19	Wilkinson & Co	\$2.75						\$2.75
20	Sam. C. Westcott	3.15	\$3.15					
21	C. W. Durham	9.50	9.50					
22	Marshall & Fisher	1.45					\$1.45	
23	Davis & Co	4.08					4.08	
24	Chas. J. Long	19.50			\$16.24		3.26	
25	Thos. E. Schindler & Co	25.40			25.40			
26	Geo. Hill	249.71						249.71
27	C. W. Durham	8.50	8.50					
28	T. Nodler	57.80			54.10		3.70	
29	Van Patten & Marks	206.01			185.35		19.06	
30	Fred. A. Bill	78.51			2.75	\$72.36	3.40	
31	C. A. Hutchinson	42.88			9.88	33.00		
32	Wollers & Wartman	3.16						3.16
33	Wm. Towle & Co	51.81						51.81
34	A. M. Riddle	11.52					11.52	
35	Ward & Brady	69.80			38.55		31.25	
36	Hired men	44.79						44.79
37	do	15.25						15.25
38	Henry A. Koettker	53.30			33.30			
39	A. Boschert & Co	53.82			53.82			
40	John M. Kelfein	120.47				120.47		
41	Dan. Kerwin	4.00						4.00
42	G. V. Halliday & Co	40.00	40.00					
43	L. T. Davis	27.00				27.00		
44	W. A. Bonsack Lumber Co	36.18						36.18
45	John Harty	56.50				56.50		
46	Gauntitz Brothers & Schwab	18.00			18.00			
47	T. Nodler	3.10			3.10			
48	Egbert, Fidler & Chambers	3.00	3.00					
49	Hired men	1,099.51		\$1,099.51				
50	P. L. Utley & Co	25.48			25.48			
51	Van Patten & Marks	224.24			208.67		15.57	
52	Robinson & Cary Co	37.89					13.89	24.00
53	Nicols & Dean	40.32					40.32	
54	Various persons	10.20			6.55	3.00	.65	
55	Hired men	685.34		685.34				
	Total	3,581.29	64.15	1,784.85	682.79	312.33	185.79	551.38
<i>June, 1891.</i>								
56	Chas. J. Long	48.65			40.00		8.65	
57	Thos. E. Schindler & Co	32.96			32.96			
58	George S. Crampton	5.30					5.30	
59	Rabe, Heitalrends & Lewis	3.25						3.25
60	Pilot Steamboat Co	110.90				110.90		
61	James Robinson & Son	21.00				21.00		
62	T. C. Bright & Co	40.00				40.00		
63	Charles J. Long	6.80					6.80	
64	Various persons	52.33			24.83	27.50		
65	Frederick A. Bill	20.00				20.00		
66	S. G. Garnett	60.00				60.00		
67	F. W. Luley & Son	43.45			43.45			
68	Albert Kirchner	6.00			6.00			
69	Frederick A. Bill	30.00				30.00		
70	C. F. Alden & Co	94.60				94.60		
71	A. Hoffmann	27.93			27.53		.40	
72	McCabe Brothers	3.75					3.75	
73	Hired men	1,274.00		1,274.00				
74	Gauntitz Brothers & Schwab	32.97			30.47		2.50	
75	F. W. Luley & Son	20.20			20.20			
76	S. G. Garnett	100.00				100.00		
77	John Hayes	600.00					600.00	
78	Frederick A. Bill	40.00				40.00		
79	James Robinson & Son	42.00				42.00		
80	Robinson & Carey Co	13.00					13.00	
81	Ben. Wilson & Son	225.32			26.77	23.50		225.32
82	Various persons	50.27			10.52	30.00		
83	Gauntitz Brothers & Schwab	40.52						
	Total	3,015.20		1,274.00	262.73	639.50	610.40	228.57

Summary of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1891.

Months.	Office expenses, superintendence, etc.	Care, repair, and operating snag boats General Barnard and J. G. Parke.					
		Labor.	Fuel.	Subsistence.	Expense.	Repairs.	Total.
1890.							
July	\$325.00	\$1,473.99	\$178.00	\$492.90	\$383.76	\$121.36	\$2,650.01
August	4.00	932.20	469.00	218.32	2.50		1,622.02
September		965.33	161.25	145.39			1,271.97
October	114.70	832.49	257.00	75.59	150.54	74.91	1,390.53
November	200.00	215.00					215.00
December	200.00	215.00				47.60	262.60
1891.							
January							
February	433.00	430.00				922.47	1,352.47
March	221.25	215.00				1,465.85	1,680.95
April	25.95	215.00				553.00	788.00
May	64.15	1,099.51	189.47	401.42	62.04	840.99	2,084.43
June	63.00	1,274.00	639.50	262.73	640.40	228.57	3,045.20
Total	1,051.05	7,867.52	1,885.22	1,596.35	1,239.24	3,754.85	10,343.18

Months.	Care, repair, and operating dredge and tender.						Grand total.
	Labor.	Fuel.	Subsistence.	Expense.	Repairs.	Total.	
1890.							
July	\$482.75	\$7.20	\$72.10	\$54.86	\$307.53	\$924.44	\$3,899.45
August	976.47	507.22	190.34	7.45	338.44	2,019.92	3,645.94
September	482.67	327.01	132.06	4.00		945.74	2,217.71
October	125.67	64.75	87.87	50.50	154.01	482.60	1,987.83
November							415.00
December					7.42	7.42	470.02
1891.							
January					75.79	75.79	75.79
February							1,785.47
March	250.00					250.00	2,152.20
April				155.86	711.29	867.15	1,061.10
May	683.34	131.86	281.37	123.75	210.39	1,432.71	3,581.29
June							3,108.20
Total	3,002.90	1,038.04	763.54	306.42	1,801.87	7,005.77	25,000.00

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 1891.

MAJOR: I have the honor to present my report on the operations of snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1891, together with some statistics of commerce and navigation:

OPERATIONS OF SNAG BOAT GENERAL BARNARD.

The *Barnard* arrived at the Des Moines Rapids Canal July 1, 1890, and lay in the lower level until July 16, during which time her hull was repainted and considerable repairs were made to roof, machinery, etc.

On July 17 she left for below, arriving at St. Louis on the 19th, and returning reached Keokuk on the 24th. On this trip a portion of one of the ice-breakers of Hamilton Bridge was removed, as also were snags and other obstructions at or near the following localities: Fox Island, Lone Tree, Cottonwood Island, Whitney, Hickory Chute, Louisiana, McCoy Island, Hatchet Chute, Mason Chute, Two Branch, Maple Island, Sterling Island, Tisdell, Carroll Island, and Marion City.

On July 25 the *Barnard* left Keokuk for above, arriving at St. Paul August 9. On this trip obstructions were removed at or near Dallas Island, Sauerwein, Oquawka,

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Keithsburg, Turkey Island, Port Louisa, Hershey Chute, Fulton Island, Arnold, Sand Prairie, Bellevue Slough, Nine Mile Island, Finley, Hurricane Island, Cassville Slough, De Soto, Victory, Coon Slough, Root River, La Crosse, Diamond Bend, and Island No. 7. On this trip, for the convenience of lumbermen, snubbing-posts were put in as follows: Two below Burlington Bridge, one on island above Sabula, and one opposite Dubuque Bay.

On August 13 the *Barnard* left St. Paul, and taking the *J. G. Parke* in tow at Nininger, proceeded down river, arriving at Des Moines Rapids Canal on the 19th, where the *Parke* was left for repairs. On the way down 53 piles were pulled out or cut off at the elevator at Wabasha, and obstructions were removed from the shore above Keithsburg bridge.

August 20 the *Barnard*, with dredge *Phoenix*, 2 dump boats, and 1 barge in tow, left the canal for up river. On August 30 arrived at Fountain City and laid up until September 4, the crew assisting dredge *Phoenix*, which was engaged in removing a portion of Island 61 and in riprapping its head. On September 5 placed dredge in position at the damaged shore protection above Alma and, after making some soundings above Read Landing Bridge, laid up until September 11.

On September 11 the *Barnard*, with fleet in tow, started up river and, leaving the fleet at Hastings, arrived at St Paul on the 12th.

On September 15 the *Barnard* left St. Paul for below, and taking 2 barges in tow, reached Heytman Landing September 20. On the way down snags were removed from channel at Merrimac, Mettlers, Grey Cloud, Island No. 17, Beef Slough, Fountain City, and Wilds, and the Pomme de Terre Dam was repaired, as also were the dam at Island 59 and the first dam below La Crosse bridge. September 20 to 23, inclusive, the *Barnard* was employed in repairing the dam across Harper Slough and the shore protection in Crooked Slough. On September 24 and 25 the crew made a survey of the river in vicinity of Prairie du Chien. September 26 to 29 the *Barnard* removed transfer incline at East Dubuque, taking out 53 rails, besides the ties and stringers.

The *Barnard* left Dubuque for below on September 29, arrived at St. Louis on October 5, and returning reached Keokuk October 10, and lay up for the winter in the Des Moines Rapids Canal above the middle lock. On this trip work was performed at or near Bellevue Slough, Hershey Boom, Keithsburg, Oquawka, Devils Island, Lone Tree, Whitney, Hickory Chute, Slim Island, Red Landing, Sterling, and Hannibal.

In 1891 the *Barnard*, having been repainted and having received needed repairs, was put in commission May 18 and proceeded down river, arriving at St. Louis on the 19th; and, thence returning up river reached Rock Island on the 27th. On this trip snags and other obstructions were removed from the river at or near Hickory Chute, Tisdell Towhead, Jersey Landing, Enterprise Island, Dardenne Island, Amaranth Island, Clarksville, Saverton, Whitney, Canton, Dallas, and Port Louisa. The *Barnard* lay at Rock Island repairing sheet-iron work until June 3, on which date she proceeded up river, arriving at St. Paul on the 10th. Leaving St. Paul on the 12th, she reached Albany on the 18th; thence returning arrived at St. Paul on the 25th; and, thence proceeding down river, tied up at Dubuque on the night of the 30th. On this trip work was performed at or near Gordon Ferry, Eagle Point, Specht Ferry, Cassville Slough, Wyalusing, Crooked Slough, Coon Slough, Pike Island, Newport, Nininger, Prescott Island, Diamond Bluff, Red Wing, Lyons, Hurricane Island, Lansing, De Soto, Picayune Island, Richmond Island, La Moille, and Fountain City. The works at Beef Slough, Minneiska, and Prairie du Chien were inspected, and several dams located at the latter point.

Summary of operations of snag boat General Barnard for the fiscal year ending June 30, 1891.

Snags removed.....	271
Leaning trees pulled back.....	639
Leaning trees felled.....	2, 130
Wreck removed.....	1
Posts and ring-bolts put in.....	8
Steamboat assisted.....	1
Railroad transfer incline removed.....	1
Miles run.....	4, 980

OPERATIONS OF SNAG BOAT J. G. PARKE.

The *Parke* was not put in commission during season of 1890. She was, however, towed from Boulanger Slough to Keokuk for repairs. In 1891, after receiving thorough repairs, she was put in commission May 10, and left for above on that day, towing a fleet of dump boats, quarter boats, and barges, a portion of which was left at

Rock Island and the remainder taken to vicinity of St. Paul, where she arrived on May 23. From the 29th until the close of the fiscal year the *Parke* lay at Nininger, her crew being used to man launch *Elsie*, which was employed as tender to dredge *Phoenix*. The *Parke* removed, on her way to St. Paul, 4 snags, and ran, towing fleet, 520 miles.

OPERATIONS OF DREDGE PHOENIX AND STEAM LAUNCH ADA.

July 16 to 18, 1890, dredge *Phoenix* removed 3 stone cribs from the raft channel just below Montrose, Iowa. In this and subsequent work of the season the towing for the dredge was performed by steam launch *Ada* and the dredging plant was towed from point to point by the snag boat *General Barnard*. August 30 to September 4 the dredge removed about 100 linear feet of the head of Island 61, near Fountain City, the dredged material being chiefly cast into deep water. September 5 to 11 the dredge was engaged in removing the wrecked shore protection at Islands 38 and 37, above Alma. The greater part of the material was cast into deep water, but a small portion was thrown upon the bank. Two stone cribs and 9 piles from the old sawmill foundation at Alma were taken out. September 12 to 22 dredge was at work widening channel at the bar above Hastings, the cut made being about 500 feet long, 110 feet wide, and to a depth of about 6 feet at low water. A strong draft of water immediately set in through the cut, which maintained a good depth of water during remainder of season. September 23 to 26, dredge removed outer end of Dam No. 7 at bar above Hastings, which had been temporarily built to too great a length. September 27 to October 3, dredge was employed making a cut along the shore above Nininger. This cut is 975 feet long, 40 feet wide, and 6 feet deep. October 4 the dredging plant was laid up for the winter in Boulanger Slough.

Summary of operations of dredge *Phoenix* and steam-launch *Ada* from July 1, 1890, to end of season.

Cribs removed	5
Piles removed	9
Dump-loads of material removed	36
Number of days casting	19.5

In 1891 the *Phoenix* was towed to St. Paul for repairs, which being completed, she was placed on June 1 at work of dredging a permanent channel in vicinity of Nininger, which work was continued until the end of the fiscal year.

RIVER NOTES.

In 1890 the river was at a good boating stage until quite late in the season, and at no time was the water very low, except in that part of the river above Hastings. Considerable trouble was experienced during the whole season at Nininger, owing to crookedness of channel, and above Burlington for a short time, due to shoal water. Dams built at the latter place caused speedy improvement. There were never less than 4 feet of water on any bar during the season, except for a few days above Burlington.

In December, 1890, raft navigators reported obstructions and desired improvements at the following points above the Des Moines Rapids: Island No. 20, head of Lake Pepin, Pine Island, Buffalo Island, Minneiska, Chimney Rock, below Winona, Homer, head of Richmond Island, Dresbach, below Bad Axe, Iowa Slough, Prairie le Sioux, Guttenberg Channel, Cassville Slough, Hurricane Island, above Eagle Point, Deadman Island, Stone Slough, Bellevue, Santa Fé, Dark Chute, Elk River Slough, Oquawka, and Devils Island.

In 1891 the river below Hastings maintained a good stage during the spring months and until June 30. Above Hastings, during June, the water has been at a low stage, but no trouble has been experienced, and all boats have run through to St. Paul without difficulty.

STATISTICS OF COMMERCE AND NAVIGATION.

Lumber.—The most important business connected with the navigation of the Upper Mississippi River and its principal tributaries is the lumber trade, which gave employment in 1890 to about 100 raft boats, valued at \$750,000. Between St. Paul and St. Louis 74 sawmills were operated by 61 wholesale lumber firms, having an invested capital of about \$35,000,000. Their manufactures in 1890 were: Lumber, 1,231,678,960 feet B. M.; shingles, 508,986,705. In addition to the manufacturers, there are large numbers of retail or distributing firms scattered along the river. In 1888, toward the latter part of the season, was inaugurated on an extensive scale the rafting of logs coming from the river above Minneapolis. This business was continued in 1889

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and 1890, and it is thought that it will become larger from year to year as the supply from the Chippewa, St. Croix, and Black diminishes. Prior to 1888 but a comparatively small amount of logs and lumber had been moved in the river between the mouth of the St. Croix and Minneapolis.

Steamboats and freight.—The principal steamboat lines on the Upper Mississippi River are the St. Louis, St. Paul and Minneapolis Packet Company, the Diamond Jo Line, and the Eagle Packet Company. There are also many independent boats carrying freight and passengers. During 1890 the amount of freight carried on boats and barges was about 338,023 tons, and the number of passengers, not including those of ferry and excursion boats, was about 124,542. Taking into consideration the logs and lumber floated in the stream, the gross tonnage for 1890 was 4,400,000 tons approximately.

Statement of distribution of lumber manufacture along the Upper Mississippi River from Minneapolis to St. Louis in 1890.

Locality.	Lumber.	Shingles.	Locality.	Lumber.	Shingles.
	<i>Feet B. M.</i>	<i>Number.</i>		<i>Feet. B. M.</i>	<i>Number.</i>
Minneapolis.....	296,506,137	156,403,300	Clinton.....	179,686,000	56,558,000
Hastings.....	11,000,000	4,000,000	Fulton.....	12,000,000	5,655,000
Prescott.....	1,500,000	1,000,000	Camanche.....	11,500,000	3,000,000
Red Wing.....	8,500,000	3,000,000	Moline.....	35,000,000	3,000,000
Alma.....	1,635,000	1,030,000	Davenport.....	85,629,000	17,700,000
Winona.....	145,000,000	83,500,000	Rock Island.....	93,000,000	18,300,000
La Crosse.....	214,028,283	111,166,000	Muscatine.....	97,272,000	50,454,000
Onalaska.....	30,867,400	17,446,750	Burlington.....	25,750,000	11,184,755
Lansing.....	20,173,000	10,000,000	Fort Madison.....	21,248,000	22,460,000
Prairie du Chien.....	14,000,000	4,000,000	Keokuk.....	13,000,000	7,000,000
Guttenberg.....	11,000,000	4,384,000	Canton.....	7,000,000	8,530,000
Dubuque.....	67,300,000	30,800,000	Quincy.....	6,500,000	2,000,000
Bellevue.....	3,090,277		Hannibal.....	25,000,000	7,000,000
Lyons.....	72,000,000	18,756,000	St. Louis.....	16,000,000	7,052,300
			Total.....	1,528,185,097	665,390,105

Statement of amount of freight received and shipped from St. Louis by the Upper Mississippi River for 5 years.

St. Louis.	1890.	1889.	1888.	1887.	1886.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Received.....	128,960	113,305	114,940	132,400	140,880
Shipped.....	22,547	47,560	50,315	36,170	46,190
Total.....	151,507	160,865	165,255	168,570	187,070

Receipts of lumber, logs, etc., at St. Louis, from Upper Mississippi River during 1887, 1888, 1889, and 1890.

Years.	White-pine lumber.	Cotton-wood lumber.	Total lumber.	Shingles.	Lath.	Pickets.	Total pieces shingles, lath, and pickets.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>
1890.....	71,739,010	15,586,800	87,325,810	45,449,150	16,336,650	603,688	62,389,488
1889.....	71,935,820	11,961,345	83,897,165	43,350,500	21,386,350	401,832	65,138,782
1888.....	79,311,387	8,734,000	88,045,387	25,743,500	14,650,367	273,744	40,667,611
1887.....	136,490,066	6,436,000	142,926,066	70,370,735	43,034,705	448,060	113,853,500

1890.

Steamboats and barges from Upper Mississippi River arrived at St. Louis.....	766
Feet (B. M.) of logs received at St. Louis from Upper Mississippi River by raft, approximately.....	30,000,000
Steamboats and barges departed from St. Louis for Upper Mississippi River.....	755

The following table affords a comparative view of the relative amount of navigation at various localities on the Upper Mississippi River for the last 3 years:

Statement of steamers, barges, and rafts passing various bridges.

Locality of bridge.	Steamboats.			Barges.			Rafts.		
	1890.	1889.	1888.	1890.	1889.	1888.	1890.	1889.	1888.
Hastings.....	.454	769	521	341	590	424	45	72	26
Winona.....	5,417	4,419	4,740	1,045	1,140	684	2,123	1,577	1,894
La Crosse.....	4,738	5,144	5,242	626	513	279	1,926	1,387	1,683
Dubuque.....	3,479	3,221	5,649	1,418	1,149	791	*890	*666	950
Sabula.....	3,244	2,457	2,315	1,275	1,118	927	1,547	1,158	*577
Clinton.....	3,034	2,592	2,627	662	531	405	*538	*653	*365
Rock Island.....	3,122	2,607	2,099	650	244	143	843	725	828
Burlington.....	1,750	1,634	1,598	767	799	274	317	268	302
Keokuk.....	1,597	1,717	1,896	635	700	1,344	• 205	199	245
Quincy.....	1,956	1,899	1,950	• 807	636	595	278	249	317
Hannibal.....	1,941	1,999	2,125	453	547	234	500	451	315
Louisiana.....	989	1,074	1,110	408	422	278	103	77	92

* Partial record.

Customs revenue and tonnage for the year ending December 31, 1890.

Port.	Collections.	Tonnage enrolled.	Vessels.
St. Louis, Mo. *	\$1,377,767.72	132,946.82	217
Burlington, Iowa.....		1,247.48	10
Dubuque, Iowa.....	11,429.57	5,508.64	26
La Crosse, Wis.....		5,160.85	59
Galesburg, Ill.....		3,280.08	32
St. Paul, Minn.....	245,205.89	2,202.99	29
Total.....	1,734,404.28	150,352.86	373

* Only a part of the St. Louis statement applicable to the Upper Mississippi River.

Internal revenue for the year ending December 31, 1890.

District.	Office.	Amount.
Minnesota.....	St. Paul.....	\$2,680,237.90
Second Wisconsin.....	Madison.....	433,023.87
Third Iowa.....	Dubuque.....	191,372.80
Fourth Iowa.....	Burlington.....	292,417.85
Fifth Illinois.....	Peoria.....	22,483,772.85
Aggregate.....		26,060,825.27

Very respectfully, your obedient servant,

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

C. W. DURHAM,
Assistant Engineer.

A A 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MINNEAPOLIS AND DES MOINES RAPIDS.

Under this head of appropriation are carried on works for the permanent improvement of through navigation. These works, which have been fully described in previous reports, consist in constructions of

rock, brush, piles, and gravel, which close side chutes and reduce the low-water channel to a proper width, and in the protection of caving banks. The appropriation also provides for a certain amount of dredging and other temporary work for the more rapid and immediate removal of obstructions to navigation.

At the commencement of the fiscal year there was available for general improvement the sum of \$61,432.01. The sum of \$500,000 was appropriated by the act of September 19, 1890, but this amount became available too late to permit of work on an extended scale during the first half of the fiscal year. Work was resumed at as early a date in 1891 as the stage of water and other circumstances permitted, and is now in progress at numerous points.

Under approved projects, work of dam construction, shore protection, and removal of rocks and bowlders has been carried on during the past year by days' labor and Government plant between Minneapolis and St. Paul, between St. Paul and Prescott, in vicinity of Fountain City and Wilds Landing, in vicinity of Crooked Slough, at Clinton, Iowa, on Rock Island Rapids, in the vicinity of Burlington and Dallas, and below Minneiska. By informal agreement work with private plant has been carried out at Read Landing and in vicinity of Teepeeota Point, at Lake City, at Burlington, and at Port Byron. Under formal contracts work has been commenced between Read Landing and Minneiska, and at Prairie du Chien.

The dredge *Phoenix* during the year cut new channels near Nininger, and furnished gravel for dam construction at Crooked Slough.

Surveys and examinations were made between Minneapolis and St. Paul, on Rock Island Rapids, at Read Landing, Prairie du Chien, Port Byron, Burlington, Montrose, and at other points where construction work was carried out.

The buoys and ranges on the Rock Island Rapids were maintained.

Extensive repairs have been made to the Government plant, and twenty new barges are in course of construction.

The details of all the above-mentioned work are fully given in the appended report of Assistant Engineer C. W. Durham, which includes full extracts from the reports of Superintendents J. D. DuShane, W. A. Thompson, and J. C. McElherne, and the report of M. Meigs, United States civil engineer, whose report includes extracts from the report of Mr. S. Edwards, United States overseer.

The act of Congress of August 11, 1888, provided in a general way for work of improvement between Minneapolis and St. Paul, and for reasons given in my last annual report and in accordance with the provisions of the river and harbor act of September 19, 1890, I presented, under date of September 30, 1890, a project for the commencement of work of removing bowlders. This work was approved October 16, 1890, and during balance of season 76 granite bowlders and 5 pieces of ledge rock were broken up and removed from channel. The act of Congress approved September 19, 1890, provided under item for "Improving the Mississippi River from the landing on the west bank below the Washington Avenue Bridge, Minneapolis, to the Des Moines Rapids," as follows: "Of which sum also fifty thousand dollars shall be expended between the Chicago, St. Paul, Minneapolis and Omaha Railroad Bridge at St. Paul, and the Washington Avenue Bridge, Minneapolis, in dredging, removal of gravel, bowlders, and broken rock, and the construction of dams and revetments." A project in conformity with the requirements of the act of Congress, was presented February 23, 1891, and approved February 28, 1891. This project proposes a continuation

of the work of removing bowlders, the construction of dams and revetments, and the dredging of gravel bars. The removal of bowlders has already been commenced and the other work will be inaugurated immediately. As stated in former reports and projects, I am of the opinion that while the lower portion of the stretch of river here considered may be made as favorable for navigation as the river below St. Paul by the work proposed, the upper portion or rapids can only be radically improved by the construction of locks and dams.

The river and harbor act of September 19, 1890, provided for dredging in the harbors of Burlington and Montrose, Iowa, and of Port Byron, Ill. A project for some of this dredging work was presented September 30, 1890 and approved October 16, 1890, and a portion of the work desired at Burlington was carried out last fall. Projects for the work desired at Montrose and Port Byron have also been presented and approved. At the former place the work has been completed by a Government dredge, and at the latter place work is now in progress under agreement with A. J. Whitney. These works have been carried out, not because the harbors were in any worse condition than at other and possibly more important points, but for the reason that special allotments were provided for the work.

During the past year new bridges have been commenced at Winona and St. Paul, and the construction of several others has been authorized.

Commercial statistics relating to the Upper Mississippi River are given in connection with the report on "Operating snag boats and dredge boats on the Upper Mississippi River." These statistics do not in any sense indicate the relations of this work to the interests of commerce and the general public. The influence which the Upper Mississippi River in an improved condition has upon freight rates must be taken as a measure of its importance. Of the amount of freight carried by railroads at river rates, as a result of the river competition, no figures can be given; but such amount is known to be very large during the season when navigation of the river is practicable.

During the past year the works heretofore constructed by the Government have continued to straighten and deepen the low-water channel of the river and to materially benefit the interests of commerce and navigation. That such benefit should continue and increase, it is necessary that the work of improvement be continued until the whole river is put under such control that the possibility of new obstructions appearing is done away with.

If the radical improvement of the Upper Mississippi River is to be continued and carried to the full limits which the immense interests involved justify, it is desirable that it should be carried on under liberal appropriations, so that the full benefit of the improvement may be secured at as early a day as is practicable. As an amount that can be profitably expended during the fiscal year ending June 30, 1893, I present an estimate of \$1,500,000.

The improvement of the Upper Mississippi River is a work which can be best carried on so gradually as to give the river itself full opportunity to assist in the formation of proper channels, and, if carried to its fullest limits, the work must extend over many years. It does not now appear desirable, or even practicable, to prepare detailed plans for the whole river so long in advance of the time when it may be possible or necessary to carry out some of the work. The existing project for this work may therefore be said to be one of general methods and the execution of detailed plans for special localities. Under the conditions named,

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no detailed estimates of cost of completing the entire work can well be now made. Projects for the expenditure of each appropriation, in accordance with approved plans and methods, are presented in lieu of a general project for the completion of work. It has been the custom in carrying out work on the Upper Mississippi to select, when funds are available, such localities for improvement as may be at the time most detrimental to navigation. Each and every locality thus improved has a beneficial result on the navigation of the whole river, and, as the shoalest bars have been improved from year to year, the ruling navigable depth has been considerably increased. By this method, the good effects of work are spread over the entire stretch of river, and the improvement of the river, considered as a whole, is made progressive, the expenditure of each successive appropriation resulting in further and immediate benefit to the interests of continuous navigation.

SUMMARY OF EXPENDITURES FOR CALENDAR YEAR ENDING DECEMBER 31, 1890.

Minneapolis to St. Paul:	
Surveys.....	\$2,988.39
Removal of rocks.....	744.51
	<hr/>
	3,732.90
St. Paul to Prescott.....	14,641.71
Read Landing and vicinity of Teepeeota Point.....	9,899.97
Vicinity of Fountain City and Wilds Landing.....	20,528.65
Repairing Pomme de Terre Dam.....	49.42
Crooked Slough.....	1,079.66
Rock Island Rapids.....	10,931.85
Buoys on Rock Island Rapids.....	389.93
Harbor at Burlington.....	2,195.18
Vicinity of Burlington and Dallas.....	23,815.12
Surveys and gauges.....	745.24
Care, repair, and construction of plant.....	9,530.53
	<hr/>
Total.....	97,540.16

GENERAL STATEMENT OF RECEIPTS AND EXPENDITURES.

Expended by vouchers from the commencement of improvement to July 1, 1891:

St. Paul to Des Moines Rapids.....	\$1,562,096.50
Minneapolis to Des Moines Rapids.....	690,662.66
Harbor at Lake City (St. Paul to Des Moines Rapids).....	13,354.17
Practical test of Adams' flume (St. Paul to Des Moines Rapids).....	* 22,176.83
	<hr/>
Total.....	2,288,290.16
Deduct amount received from sales of fuel.....	\$946.68
Deduct amount received by transfer settlement with Quartermaster's Department, account of sale of fuel to officers.....	156.29
Deduct amount received from sale of rock.....	1,078.05
	<hr/>
	2,181.02
	<hr/>
Net cost of improvement.....	2,286,109.14
Balances July 1, 1891:	
St. Paul to Des Moines Rapids.....	†\$2,045.88
Minneapolis to Des Moines Rapids.....	409,344.98
	<hr/>
	411,390.86
	<hr/>
Total appropriated.....	2,697,500.00

* In addition to this amount Mr. Adams expended \$8,000, appropriated by act of August 2, 1882, as a separate item.

† Of this amount \$1,645.83 pertain to Lake City Harbor and \$248.40 are nonpayments.

ABSTRACT OF APPROPRIATIONS.

St. Paul to Des Moines Rapids:

By act approved—

June 18, 1878	\$250,000
March 3, 1879	100,000
June 14, 1880	150,000
March 3, 1881	200,000

By act passed August 2, 1882.....

250,000

By act approved—

July 5, 1884 (general improvement)	250,000
July 5, 1884 (applied to harbor at Lake City)	15,000
August 5, 1886	382,500

Minneapolis to Des Moines Rapids:

By act of August 11, 1888..... 600,000

By act of September 19, 1890..... 500,000

Total 2,697,500

Net expenditures on the various sections of the river between Minneapolis and the Des Moines Rapids from commencement of improvement to July 1, 1891.

Locality.	Distance.	Amounts.
	<i>Miles.</i>	
Minneapolis to St. Paul (Omaha Bridge)	11	\$6,147.00
St. Paul (Omaha Bridge) to Prescott	32	511,103.56
Prescott to head of Lake Pepin	29	56,228.37
Harbor at Lake City		13,354.17
Foot of Lake Pepin to Alma	12	278,312.56
Alma to Winona Bridge	29	279,942.36
Winona Bridge to La Crosse Bridge	31	109,544.59
La Crosse Bridge to McGregor Bridge	72	96,305.75
McGregor Bridge to Dubuque Bridge	59	82,728.35
Dubuque Bridge to Clinton Bridge	67	57,297.13
Clinton Bridge to Rock Island Bridge	40	95,955.58
Rock Island Bridge to Keithsburg Bridge	58	70,071.85
Keithsburg Bridge to Des Moines Rapids	60	394,370.50
Surveys, gauges, and meter-work		91,765.51
Snag and dredge boats and wrecking		39,431.06
Facilitating navigation through bridges		1,360.38
Plant at estimated value		79,947.00
Practical test of Adams' flume		22,176.83
Total		2,286,109.14

FINANCIAL STATEMENTS.

1. General improvement.

July 1, 1890, balance available	\$61,432.01
Amount appropriated by act of September 19, 1890	500,000.00
Received by transfer settlement with Quartermaster's Department, account of sale of fuel to officers	156.29
	561,588.30

July 1, 1891, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1890	\$151,843.27
July 1, 1891, outstanding liabilities	2,277.94
July 1, 1891, amount covered by uncompleted contracts	50,834.11
	204,955.32

July 1, 1891, balance available..... 356,632.98

2. Applied to Lake City, Minn. (Act of July 5, 1884.)

July 1, 1890, balance available	\$2,515.83
July 1, 1891, amount expended during fiscal year	870.00
July 1, 1891, balance available	1,645.83

* Of this amount \$32.75 are nonpayments on account of test of Adams' flume.

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ST. PAUL TO DES MOINES RAPIDS.

Money statement.

July 1, 1890, balance unexpended.....	\$2, 764. 23
Received by transfer settlement with Quartermaster's Department, account of sale of fuel to officers	151. 65
	<hr/> 2, 915. 88
June 30, 1891, amount expended during fiscal year	870. 00
	<hr/> 2, 045. 88
July 1, 1891, balance unexpended.....	248. 40
July 1, 1891, outstanding liabilities.....	
	<hr/> 1, 797. 48

MINNEAPOLIS TO DES MOINES RAPIDS.

Money statement.

July 1, 1890, balance unexpended	\$61, 432. 01
Received by transfer settlement with Quartermaster's Department, account of sale of fuel to officers	4. 64
Amount appropriated by act approved September 19, 1890:	
General improvement	\$408, 000
Between Chicago, St. Paul, Minneapolis and Omaha Railroad Bridge and Washington Avenue Bridge.....	50, 000
Burlington, Iowa	5, 000
Montrose, Iowa	2, 000
East Channel, Prairie du Chien.....	30, 000
Port Byron, Ill.....	5, 000
	<hr/> 500, 000. 00
	<hr/> 561, 436. 65
July 1, 1891, amount expended during fiscal year:	
General improvement.....	\$138, 616. 47
Between Chicago, St. Paul, Minneapolis and Omaha Railroad Bridge and Washington Avenue Bridge.....	2, 312. 25
Burlington, Iowa	1, 905. 62
Montrose, Iowa	1, 278. 93
East Channel, Prairie du Chien.....	6, 617. 54
Port Byron, Ill.....	1, 360. 86
	<hr/> \$152, 091. 67
July 1, 1891, balance unexpended.....	409, 344. 98
July 1, 1891, outstanding liabilities:	
General improvement	\$1, 404. 25
East Channel, Prairie du Chien.....	625. 29
	<hr/> 2, 029. 54
July 1, 1891, amount covered by uncompleted contracts:	
General improvement	38, 261. 73
East Channel, Prairie du Chien.....	12, 572. 38
	<hr/> 50, 834. 11
	<hr/> 52, 863. 65
July 1, 1891, balance available.....	356, 481. 33
July 1, 1891, amounts available under general and special allotments are as follows:	
General improvement.....	\$291, 154. 20
Between Chicago, St. Paul, Minneapolis and Omaha Railroad Bridge and Washington Avenue Bridge.....	47, 687. 75
Burlington, Iowa	3, 094. 38
Montrose, Iowa	721. 07
East Channel, Prairie du Chien.....	10, 184. 79
Port Byron, Ill.....	3, 639. 14
	<hr/> 356, 481. 33
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	1, 500, 000. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., February 20, 1891, at 2 p. m., for "constructing and repairing dams and shore protections of brush and rock between Reads Landing, Minnesota, and Minniska, Minn."

[There is available for this work from appropriation of \$500,000 made by river and harbor act of September 19, 1890, for "improving Mississippi River from Minneapolis to Des Moines Rapids" an allotment of \$50,000 made by project approved January 6, 1891.]

No.	Name and residence of bidder.	Rock in place, 25,000 cubic yards.		Brush in place, 20,000 cubic yards.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	Nehemiah Martin and Timothy Mitchell, Hastings, Minn.	\$1.85	\$33,750	\$0.60	\$12,000	\$45,750
2	Andrew Delaney, St. Paul, Minn.	1.15	28,750	.60	12,000	40,750
3	Albert Kirchner, Fountain City, Wis.	1.17	29,250	.50	10,000	39,250
4	Jacob Richtman, Fountain City, Wis.	1.20	30,000	.27	5,400	35,400
5	Wm. A. Patterson and Sabret T. Patterson, Keokuk, Iowa	1.35	33,750	.48	9,600	43,350
6	A. J. Whitney, Rock Island, Ill.	1.20	32,500	.65	13,000	45,500

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., February 20, 1891, at 2 p. m., for construction of dams and shore protections of brush and rock in vicinity of Prairie du Chien, Wisconsin.

[There is available for this work an allotment of \$30,000, made by the river and harbor act of September 19, 1890, from appropriation of \$500,000 for "improving Mississippi River from Minneapolis to Des Moines Rapids."]

No.	Name and residence of bidder.	Rock in place, 14,000 cubic yards.		Brush in place, 14,000 cubic yards.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	Nehemiah Martin and Timothy Mitchell, Hastings, Minn.	\$1.35	\$18,900	\$0.60	\$8,400	\$27,300
2	James Coleman and John H. S. Coleman, Davenport, Iowa.	1.25	17,500	.45	6,300	23,800
3	Andrew Delaney, St. Paul, Minn.	1.18	16,520	.60	8,400	24,920
4	Sid. J. Truax and George J. Hetherington, Hastings, Minn.	.89	12,480	.44	6,160	18,620
5	Albert Kirchner, Fountain City, Wis.	1.09	15,260	.39	5,460	20,720
6	Jacob Richtman, Fountain City, Wis.	.90	12,600	.50	7,000	19,600
7	William A. Patterson and Sabret T. Patterson, Keokuk, Iowa.	.90	12,600	.40	5,600	18,200
8	A. J. Whitney, Rock Island, Ill.	1.00	14,000	.60	8,400	22,400

Abstract of proposals received and opened by Maj. A. Mackenzie, Corps of Engineers, at Rock Island, Ill., February 20, 1891, at 2 p. m., for constructing dams and shore protections of brush and rock between Bellevue, Iowa, and Savanna, Ill.

[There is available for this work from appropriation of \$500,000, made by river and harbor act of September 19, 1890, for "improving Mississippi River from Minneapolis to Des Moines Rapids," an allotment of \$25,000 made by project approved January 6, 1891.]

No.	Name and residence of bidder.	Rock in place, 13,000 cubic yards.		Brush in place, 10,000 cubic yards.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	Nehemiah Martin and Timothy Mitchell, Hastings, Minn.	\$1.40	\$18,200	\$0.60	\$6,000	\$24,200
2	James Coleman and John H. S. Coleman, Davenport, Iowa.	1.25	16,250	0.45	4,500	20,750
3	Andrew Delaney, St. Paul, Minn.	1.28	16,640	0.64	6,400	23,040
4	Sid. J. Truax and Geo. J. Hetherington, Hastings, Minn.	1.14	14,820	0.40	4,000	18,820
5	Albert Kirchner, Fountain City, Wis.	1.09	14,170	0.39	3,900	18,070
6	Jacob Richtman, Fountain City, Wis.	1.20	15,600	0.27	2,700	18,300
7	William A. Patterson and Sabret T. Patterson, Keokuk, Iowa.	0.90	11,700	0.38	3,800	15,500
8	A. J. Whitney, Rock Island, Ill.	1.00	13,000	0.60	6,000	19,000

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 31, 1891.

MAJOR: I have the honor to submit the following report of operations for the improvement of the Mississippi River in the division under my charge, extending from Minneapolis, Minn., to the vicinity of Burlington, Iowa, for the calendar year ending December 31, 1890:

MINNEAPOLIS TO ST. PAUL.

Surveys and examinations.—On April 29, 1890, an examination of this part of the river was made, the party starting from Minneapolis with a skiff, with a view to inquiring into the feasibility of improving navigation by removal of rocks and bowlders. A very swift current was found for the greater part of the way to Meeker Island and much rough water, indicating the existence of many rocks and bowlders. The least depth of water found was 3 feet, the stage at St. Paul by the engineer gauge reading 2.8 feet. Below Meeker Island no serious obstruction was met with, except a row of cribs with connecting chain across the channel at a point about 1 mile above Minnehaha Creek.

On May 1 the launch *Ada*, drawing about 2 feet, went through from St. Paul to Minneapolis without difficulty, the only delay being caused at the cribs above mentioned, where the chain had to be cut. On May 5, at a stage of 2.6 feet at St. Paul, the *General Barnard*, drawing 3 feet and 3 inches, ran without trouble from St. Paul to the point where the boom company has placed the cribs, and was then obliged to turn back. On June 26, at a stage of 6.2 feet at St. Paul, the *Barnard* went up as far as the Franklin Avenue Bridge and was there stopped by rocks. These rocks removed, she can probably go to Minneapolis at a 5-foot stage. By these examinations it was demonstrated that the channel could be considerably improved by removing rocks and bowlders, which exist in great numbers.

In June and July accurate surveys of the river were made by a party in charge of Superintendent J. D. Du Shane from the Minneapolis steamboat warehouse to a point 1,200 feet below the Franklin Avenue Bridge; from head of Meeker Island to Short Line Bridge; at Marshall Avenue Bridge, Groveland Park, Minnehaha Creek, and Pike Island. The cost of these surveys, including work in the office, was \$2,988.39. From Mr. Du Shane's report the following extracts are taken:

"Actual work of the rapids survey began June 9, the time from the 4th to the 7th being used for establishing stations, setting gauges, and practicing the crew in handling the sounding boat in the rapid current when not interrupted by rain.

"As the current was too rapid for holding the sounding boat on line with oars, a special tackle, described as follows, was devised for maneuvering it: A 1-inch rope, about 1,000 feet long, was stretched across the river about 10 feet above water and made taut by a capstan at one end; on this holding line ran a snatch-block to which a half-inch rope or dropping line 250 feet long led from the sounding boat; to the block were also attached two half-inch ropes or hauling lines, each long enough to reach across the river and supported, on each side of the block, on the 1-inch holding-line by 24-inch iron rings fixed to the hauling-lines at points 25 feet apart by small cold-shuts. The sounding boat could thus be held against the rapid current, dropped downstream, and hauled across river as required. In practice the holding-line was kept perpendicular, as near as may be, to the direction of the current, and was changed in position up or down river as work progressed, from 100 to 200 feet at each moving, three skiffs being placed under the line at suitable points for holding it out of the swift water while being moved. The sounding boat, a small yawl, was dropped 10 feet at a time, making the sounding lines practically parallel from shore to shore and 10 feet apart; the boat was hauled across the river by two men on each shore, the speed being maintained as uniform as practicable and the soundings being taken at intervals of 10 to 15 feet on each line. The soundings were located by intersection from two transit instruments on shore, the intersections being taken at every fourth sounding on the sounding rod at the instant of verticality, a signal being given from the sounding boat.

"In this manner the river was thoroughly sounded from a point 100 feet above the Minneapolis steamboat warehouse to a point 1,200 feet below the Franklin Avenue Bridge, near the head of Meeker Island, a distance of 7,000 feet. Within this distance a search, as thorough as the stage of water would permit, was made for rocks, and 175 rocks, bowlders, and patches were located. Many more smaller bowlders could have been located had the water been at a lower, more favorable stage, as many of the bowlders did not show a distinct break in the rough water of the rapids at the time of survey, especially in the vicinity of the Franklin Avenue Bridge. However, the largest were located and many of the others can be readily found dur-

ing the progress of any operations which may be undertaken for the removal of those already located.

"Soundings, in continuation of those on the rapids, were taken from the head of Meeker Island to the Short Line Bridge, a distance of 2,600 feet. The soundings were taken 15 to 20 feet apart, on parallel lines 40 feet apart, extending from shore to shore. The tackle having been abandoned at the foot of the rapids, these soundings were taken from a rowboat and located as above described. Twenty-two bowlders were located within this distance.

"The bottom of the river from the Minneapolis landing to the Short Line Bridge is composed of bowlders varying in size from one-half foot to 2 feet or more, mixed in places with coarse gravel; it may be likened to a street paved with cobble stones, so closely are the bowlders packed. A narrow bar in mid-stream, composed of coarse gravel and small bowlders, extends from above the Minneapolis Landing down river several hundred feet. This bar is dry, or nearly so, at its upper end during low summer stages.

"In addition to the above survey there were made examinations of shoals at the Marshall Avenue Bridge, Groveland Park, Minnehaha Creek, and Pike Island. The length of river covered by these examinations is about $\frac{3}{4}$ miles. Soundings were made from a rowboat and located by intersections with two transit instruments. The soundings were taken 15 to 20 feet apart on parallel lines across the river 40 feet apart, except at Marshall Avenue Bridge, where the lines are 25 feet apart, and at Groveland Park, where for one-third of the distance the lines are 20 feet apart.

"At Marshall Avenue Bridge the bottom is composed of small bowlders and coarse gravel; at Groveland Park the bottom is similar to that at Marshall Avenue Bridge, excepting along the right bank, where for 50 to 100 feet from shore is a deposit of sawdust, slabs, and muck. At Minnehaha Creek the bottom is gravel, with scattering small bowlders, while at Pike Island it consists entirely of gravel, excepting near the shores, where it seems to be composed of sand, sawdust, and slabs.

"Temporary gauges were established at Minneapolis Landing, Franklin Avenue Bridge, and Groveland Park. Daily readings of these gauges and of that at St. Paul were kept.

"Permanent bench-marks were established at Minneapolis Landing, Franklin Avenue Bridge, and Marshall Avenue Bridge. The first two were connected by levels, carefully taken, with bench-marks of Major Allen's survey of 1887.

"Permanent stations were made at all but three of the transit stations occupied for locating soundings on the rapids survey. These permanent stations consist of granite bowlders, set firmly in the ground and marked with a \times (cross) chiseled into the top of the bowlder, the center of cross being center of station. In most cases these stations have been referenced and are fully described on map, and they may be readily identified for future work. * * *

"Observations were taken for velocity of the current on the rapids." * * *

Operations in removing rocks and bowlders.—This work was in charge of Superintendent Du Shane, whose report is here given:

"The river and harbor act of September 19, 1890, providing for improving the Mississippi River from Minneapolis to the Des Moines Rapids, designated that of the sum appropriated '\$50,000 shall be expended between the Chicago, St. Paul, Minneapolis and Omaha Railroad Bridge at St. Paul and the Washington Avenue Bridge, Minneapolis, in dredging, removal of gravel, bowlders, broken rock, and the construction of dams and revetments.'

"Under a project, dated September 30 and approved October 14, 1890, work of removing rocks from the river bed below Minneapolis was begun by a small party on October 16. This work was carried on by day's labor. Between the Franklin Avenue and Short Line bridges there were removed by blasting 76 granite bowlders and 5 pieces of ledge rock. The bowlders varied in size from 1.5 feet to 6 feet in diameter; the ledge rock from 4 feet by 4 feet to 8 feet by 15 feet on one face. The thickness of ledge rock was not ascertained, though the holes drilled for blasting were from 2.5 feet to 3 feet in depth. With a few exceptions all these rocks were so completely broken up as to leave no trace. Whenever large pieces of rock remained after blasting, they were either hauled ashore or further broken up by blasting. It is thought that all of the most dangerous rocks within the channel limits between these bridges have been removed.

"Owing to cold weather, with heavy snow, operations for the season were suspended November 8.

"Cost of removing rocks, including quota of office expenses, is \$744.51.

"As part of a general system for the permanent improvement of the river between Minneapolis and St. Paul, work should be done during the season of 1891 at the following places: Opposite foot of Pike Island, removal of several log cribs from the channel and protection of left bank (this high, sandy bank is being rapidly washed into the river, forming an obstructing bar at the foot of the island); at Fisherman Island, removal of log cribs from channel and cut dredged through gravel bar, the

gravel to be used for closing-dams in side chutes; possibly some dredging below and above Marshall Avenue Bridge; below the Short Line Bridge, removal of a few scattering rocks; removal of rocks on rapids above Franklin Avenue Bridge and between the head of rapids and the landing on west bank below the Washington Avenue Bridge.

"While it is not thought that the removal of bowlders and rocks from the rapids will furnish a permanently improved channel sufficient for safe and easy passage by the larger classes of steamboats, it will no doubt answer all the requirements of navigation; for, at least until a system of improvement by locks and dams is completed, this stretch of river will be put to little commercial use, except for running logs from Minneapolis to the boom works below Pike Island. However, should locks and dams ever be built, much of the work near the head of the rapids and all that above the rapids previously mentioned as work that should be done during 1891 would form a part of the permanent improvement by this system.

On October 12, 1890, when the United States engineer gauge at St. Paul read 1.1 feet, the general depth of river in channel on the rapids above Franklin Avenue Bridge was 2.5 feet, though bowlders and rocks projecting above the river bottom rendered these rapids unnavigable at this stage for any class of steamboats. The navigable depth in channel at Meeker Island was 3 feet; above and below Marshall Avenue Bridge, 2.5 feet; at Fisherman Island, 1.5 feet; below same, 3 feet; below Fort Snelling, 3 feet; between St. Paul and Prescott, 3.5 feet.

"In recent years the quantity of mill refuse dumped into the river at Minneapolis has greatly diminished, but there is yet a large amount going in throughout the greater part of the year. The quantity of city refuse and garbage deposited in the river is, however, on the increase. Since the city crematorium was abandoned, about 1 year ago, all the garbage and other refuse collected from this city of over 160,000 inhabitants is, I am informed, deposited in the river. This city refuse proves not only a nuisance and a constant menace to the health of a large community along the river, but also helps to form obstructions to navigation at least as far as Prescott, Wis., 44 miles below Minneapolis, and, possibly, to Lake Pepin, some 20 miles farther. In the interests of navigation and of the health of steamboatmen and of those connected with river improvements and dependent works, whose occupation requires them to live on the river during a great part of the year, it can not be urged too strongly that all deposits in the river of refuse from the mills and from the city should cease. Moreover, it is not to be expected that the river can be permanently improved for navigation between Minneapolis and St. Paul so long as these deposits continue."

In regard to the stretch of the Upper Mississippi River between Minneapolis and St. Paul (Omaha Bridge), it may be said that from St. Paul to Minnehaha Creek the river is of the same general character as the river between St. Paul and Prescott and can readily and cheaply be improved and adapted to the navigation of the largest boats plying the Upper Mississippi by the methods employed on the river below St. Paul. But, from Minnehaha Creek up, the river assumes a different character, the current being much swifter, in fact at some points so rapid that even boats of considerable power would have great difficulty in stemming it, and the bottom at many points is composed of gravel or rock, with large accumulations of bowlders. By removing broken rock, gravel, and bowlders, as called for in the act of September 19, 1890, the channel will be only partially improved as to depth, perhaps enabling boats to go up at a somewhat lower stage than at present possible. Even if the channel were deepened and widened by the expensive excavation of the solid-rock bottom, the force of the current would come into play, seriously retarding or effectually checking boats heavily laden or of smaller power, so that it is believed, and this belief has heretofore been expressed by many others, that to practically improve the upper part, say from Minnehaha Creek, or at all events from Meeker Island, to the Washington Avenue Bridge, some form of canalization or slackwater improvement will be necessary.

ST. PAUL TO PRESCOTT.

Under project of August 13, 1890, operations were carried on by hired labor and Government plant, material being purchased in open market. Details of this important work are given in the following extract from the season's report of Mr. J. D. Du Shane, superintendent in local charge:

"Operations were resumed September 8, 1890, at Pine Bend. Dams 24 and 25 (sheet 4), left unfinished in 1889, were completed; dam 22 (sheet 4) was lengthened. At this place, as a result of the works of improvement accomplished during 1889 and 1890, a most desirable correction of the river was made, the channel now following the bend along the right bank.

"On September 24 the fleet was moved to Grey Cloud Landing. The shore protection of Island 13 was repaired. Dams 44, 45, 46, 47, 48, and 49 (sheet 4) were con-

structed; Dams 44 and 45 are located below Dams 7 and 32, respectively, while Dams 46, 47, 48, and 49 are built from the right bank below Island 13. By these dams the water was directed from the right bank and held down the middle of the river. The rectified channel now continues directly from the foot of Island 13 to Grey Cloud Landing.

"The fleet was moved, October 24, to Nininger, where Dams 32 and 33 (sheet 5) were built from the left bank belows Dam 28. Dams 2, 26, 27, 30, and 31 (sheet 5) were raised.

"Operations were suspended on November 3, and the fleet was laid up for the winter in Boulanger Slough on November 4.

"On September 12 the dredge *Phoenix*, attended by launch *Ada*, began a cut through the bar opposite Dam 10 (sheet 6). This cut was finished September 23; length of cut, 500 feet; width, 110 feet. The dredge then removed the outer (temporary) end of Dam 7 (sheet 6). On September 27 the dredge was moved to Nininger, where a cut through the bar along the right bank was begun the same day, the material being cast on shore. The cut is 975 feet long and 40 feet wide. This work was suspended October 3. The dredge and two dumps were laid up for the winter in Boulanger Slough and the launch *Ada* turned over to Superintendent W. A. Thompson on October 4.

"Works of improvement should be constructed during the season of 1891 at the following places, or so much thereof as funds will permit or the interests of navigation demand, all of which works form part of the general system projected for the permanent completion of the stretch of river under consideration: Dam above Dam 13 (sheet 2); dam below Dam 28 (sheet 2); dams at Islands 4, 5, 6, and 7; dams below Grey Cloud Landing; dams opposite Nininger; dams above and below Hastings; shore protection opposite Island 1 may need extending, also that below Newport and that below Pine Bend; the left bank below Island 17 and the right and left banks above Hastings should be protected.

"Repairs should be made as follows: Dams at Island 1; dams opposite Newport; revetment above and dams opposite, Robinson Rocks; dams below Nininger.

"The condition of the river at Nininger during the latter part of the season was such as to cause boats much trouble; the channel, being not only shoal in places but narrow and very crooked, rendered it impossible for the larger class of steamboats, bound upstream, to pass this place without going ashore, there not being sufficient room for maneuvering. While this status existed no relief could be afforded by works of improvement, for to undertake any work at this time would mean the complete obstruction of navigation during the remainder of the season. In all probability close attention will be demanded here at the opening of navigation in 1891 should a low stage of water prevail. A medium stage will be the most advantageous for continuing operations, as it is essential to good work here to create deposits below the dams of the obstructing sand, requiring it to travel the least possible distance downstream. Work should be commenced here as soon as practicable in order that these bars be kept out of the channel immediately below, where, for the next mile and one-half, the works of improvement are now practically completed. Should these bars get into this piece of river, trouble will ensue during the time required for the bars to travel this distance at least 2 or 3 years. The bars are already so far advanced that to secure the best results it may be necessary to operate the dredge, even at serious disadvantage, in connection with construction work.

"While speaking of operating a dredge in connection with construction work it may be proper to state that for removing temporary obstructing bars more or less dredging will be necessary during the continuance of work for regulating the river, and also occasionally after the completion of these works. It is not to be expected that all moving sand will be completely controlled by the works when finished to the present adopted channel width, and so long as such moving sand remains within the channel limits, so long will temporary obstructing bars form, and the need exist for their speedy removal, if the best interests of navigation are to be served and consequently promoted. To accomplish this removal for some years after the regulation works are completed, a dredge will be required at least a small part of the season of navigation. Owing to the advanced state of the work in this stretch of river and the large accumulations of sand between the dams and back of islands, accessible dumping grounds are becoming scarce, so that only occasionally can a place be found convenient for dumping dredged materials. A hydraulic dredge would, I believe, furnish a means both convenient and economical for removing or reducing these temporary bars. By this method the dredged material could be deposited, through pipes, near shore between the dams, where it is not only most desirable, but also most difficult to create deposits by the aid of regulation works alone. Filling these pockets, which frequently exist, thus connecting the shores with the deposits already created by the dams, would result in a double benefit; namely, removing the obstructing bars from the channel and preventing the formation of other obstructing bars by sand which is carried out into the channel again from deposits once created and so desirable to retain, the movement of this sand being due to a current

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at certain stages of water, running in on the lower side of the dam down near shore, and out into the river above the dam next below.

"It is not expected that enough work would be found in this stretch of river to keep a pump dredge fully occupied, but it could be employed for similar work on other parts of the river and, possibly, to great advantage at the Des Moines Rapids Canal.

"In the matter of depositing city refuse in the river, a great change has taken place at St. Paul within the past year. An azotine plant now consumes a vast amount, and by that much at least is the quantity deposited in the river decreased. It is to be hoped that means will be found for keeping all the refuse from this city out of the river,

A list of works constructed and repaired, and of materials used during the season of 1890, between St. Paul and Prescott.

Works.	Dimensions.		Material.	
	Length.	Height above low water of 1884.	Rock.	Brush.
Sheet 4:	<i>Feet.</i>	<i>Feet.</i>	<i>Cubic yards.</i>	<i>Cubic yards.</i>
Dam 44	390	4.5	409.6	1,048.8
Dam 45	410	4.5	493.3	1,314.3
Dam 46	280	4.0	364.2	964.8
Dam 47	270	4.0	410.6	804.6
Dam 48	220	4.0	390.7	1,135.1
Dam 49	175	4.0	323.9	1,107.6
Dam 22, extended	40	.....	120.7	441.9
Dam 24, finished	525	4.0	534.9	832.9
Dam 25, finished	640	4.0	643.4	1,891.6
Dam 38, raised .....	.....	4.0	62.7	.....
Dam 40, raised .....	.....	4.0	59.5	.....
Revetment Island 13, repaired .....	.....	.....	80.5	.....
Sheet 5:				
Dam 32	215	4.5	328.5	787.9
Dam 33	225	4.5	319.2	650.3
Dam 2, raised .....	.....	4.0	49.0	.....
Dam 26, raised .....	.....	4.5	120.2	262.1
Dam 27, raised .....	.....	4.5	140.4	335.5
Dam 30, raised .....	.....	4.5	102.9	137.5
Dam 31, raised .....	.....	4.5	120.3	349.1
Total .....	.....	.....	5,074.5	12,044.0

"The materials were purchased in open market delivered on United States barges at the following prices: Rock, 44.5 cents per cubic yard; brush, 26 cents per cubic yard; poles, 3 cents each.

Financial statement for works of improving Mississippi River between St. Paul and Prescott during the season of 1890.

Amount expended in the field during the calendar year 1890 (from distribution sheets)	\$12,775.79
Add cost of materials from 1889	898.59
	13,674.38
Deduct for materials on hand 1890	\$505.78
Deduct for expense of cutting temporary channels	765.00
	1,270.78
Net cost of field work	12,403.60
Add quota of general superintendence and office expenses	1,865.92
Add for use and deterioration of plant	3,276.40
Total cost of work	17,545.92
Material put in works:	
Rock	cubic yards.. 5,074.5
Brush	do..... 12,044.0
Total	do..... 17,118.5

Average cost per cubic yard on barges.....	\$0.321
Average cost per cubic yard for towing and putting in material.....	.404
Average cost per cubic yard for general superintendence and office expenses.....	.109
Average cost per cubic yard for plant.....	.191
Average cost per cubic yard in place.....	1.025

PRESCOTT TO LAKE PEPIN.

Owing to the late passage of the river and harbor bill and the greater need of work above Prescott, no work was undertaken in this stretch of river during season of 1890.

READ LANDING AND VICINITY OF TEEPEEOTA POINT.

In order to regulate the channel above Read Landing Bridge, which had become very crooked and difficult to run, two wing dams were built out from the right bank. Some needed repairs were made to dams in vicinity of Teepeeota Point. There follows the report of Mr. W. A. Thompson, superintendent in local charge:

"For many years a bad bar has been across the steamboat channel opposite Read Landing and above the ponton of the railroad bridge which caused many requests to be made by steamboat owners that something be done by the Government to make a permanent and easy channel above and through the bridge draw.

"Owing to the lack of funds, nothing could be done before October, when an agreement was entered into with Jacob Richtman, of Fountain City, Wis., for the construction of wing dams above the bridge from the Minnesota shore. The price was \$1.15 per cubic yard for rock in place, and 54 cents per cubic yard for brush in place.

"Two wing dams were constructed; one (No. 4, sheet 13), from a point on shore 1,500 feet above the west end of the railroad bridge, and the other (No. 5, sheet 13), from a point on shore 615 feet further upstream. These dams were built very strong, owing to the great quantity of heavy ice that comes out of Lake Pepin nearly every spring and would come directly against these dams. Extra heavy double mattresses of brush were used and weighted well with rock. Dam No. 4 has an average width of 35 feet and Dam No. 5 a width of 40 feet. The construction of these dams was commenced October 18 and was completed November 19. These dams cause a large volume of water to be thrown into the main channel that before passed through the opening of the bridge west of the draw. No further trouble to boats crossing this bar is expected.

"In 1878 and in 1880, several wing dams were built in vicinity of Teepeeota Point. For many years previous navigation had been very difficult in low stages of the river. After the construction of these dams no complaints were heard from river men regarding the condition of this part of the river until a year or two ago. Upon examination, several of these dams were found to be in very bad condition. Several have had breaks that draw off a large quantity of water from the main channel.

"After the dams at Read Landing were completed, Captain Jacob Richtman was authorized to begin making these repairs, at the same prices for material as he received at Read Landing. This work being commenced late in the season, only two of the dams could be repaired. Dam 4 (sheet 14), from the right bank at Teepeeota Point, had a bad hole in it and the shore protection had been washed away. This dam was put in good condition and work on Dam 9 (sheet 14) was commenced. This dam is from a small towhead at the mouth of the Zumbro River. The old shore protection had been washed away and the towhead from which the dam had originally been built had cut away, back 150 feet from the end of the dam. The depth of water in this open space was from 12 feet to 16 feet. Across this hole a new dam was built and a new shore protection put in where the dam now connects with the shore.

"Work was suspended December 3.

"It is recommended that the remainder of these dams be repaired as soon as possible.

"Mr. C. A. Stoddard, inspector, performed his duties with zeal and ability."

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*List of works constructed, with amounts of materials used during the season of 1890, at
Reed Landing and vicinity of Teepeeota Point.*

Designation.	Dimensions.		Material.	
	Length.	Height above low water of 1884.	Rock.	Brush.
Sheet 13:	<i>Feet.</i>	<i>Feet.</i>	<i>Cubic yards.</i>	<i>Cubic yards.</i>
Wing Dam 4 (new).....	750	4.0	2,447.4	1,724.8
Wing Dam 5 (new).....	380	4.0	1,398.1	1,214.9
Sheet 14:				
Wing Dam 4, repaired.....		3.0	569.4	412.2
Wing Dam 9, repaired.....		3.0	755.0	615.3
Total			5,168.9	3,967.2

Financial statement for works at Reed Landing and vicinity of the Teepeeota Point, performed under agreement during season of 1890.

Amount paid contractor.....	\$8,067.69
Cost of local inspection, etc	495.67
Add quota of general superintendence and office expenses	1,316.61
Total cost of work	9,899.97

Material put in:	
Rock	cubic yards.. 5,168.9
Brush	do..... 3,967.2
Total	do..... 9,137.1

Average cost per cubic yard in place	\$1.083
--	---------

REPAIRING DAM AT HEAD OF POMME DE TERRE SLOUGH.

One barge load of rock was placed in the break of the long dam at Pomme de Terre Slough, the labor being performed by the crew of the snag boat *General Barnard*. Cost of rock used was \$42.90.

VICINITY OF FOUNTAIN CITY AND WILDS LANDING.

Owing to lack of funds, operations at these localities were not commenced until October.

From the report of Mr. W. A. Thompson, superintendent in local charge, the following is taken:

"This work was performed by Government plant and days' labor. The launches *Emily* and *Ada* left Boulanger Slough October 4, with barges 22, 36, 66, 68, 76, 97, building barge 41, quarter boat 75, pile driver 73, and grasshopper in tow. October 6 this fleet reached Argo Bar, 2 miles below Wilds Landing, where the first work was to be done. The launch *Ada* proceeded to Heytman Landing and returned to Argo Bar October 8, with barges 101 and 102 in tow.

"At Argo Bar a great deal of trouble had been experienced by steamboats and rafts during the last season. The channel was originally down the east shore, but in 1889 there were 2 channels; one, as before, down the east side and the other down the west side, neither being good. It was believed that then was the time to force the channel to the west side, as proposed in the approved project for this stretch of the river. Owing to the lateness of the season, it was impossible to do all the work necessary for the permanent improvement of this part of the river; and, owing to lack of funds, work could not be resumed until late in the season of 1890.

"To put a good channel down the west side, Wing Dam 47 (sheet 18), that had been commenced the fall before, was raised an average height of 6 feet, making the crown of the dam 4.5 feet above low water, and Closing Dam 2 (sheet 18) was repaired and raised about 4 feet, making the crown of this dam 4 feet above low water. By these means the river was reduced to about one-half its original width, and a good, straight 5-foot channel was made, where it was proposed to have it. No further trouble is

expected at this point. This work was completed October 20, and the fleet moved up to head of Blackbird Island (No. 65) one mile above Wilds Landing. Here, as at Argo, a great deal of trouble was experienced in getting rafts around the head of the island, as a high sand bar had formed above and worked down till there was, by most skillful handling on the part of the pilots and favorable winds, just room enough for a half raft to pass through, and for several months this could only be done in daylight. Many rafts had caught on the bar and then swung around onto the head of the island and broken up, causing great delay and cost to the owners.

"In 1881, two closing dams were built west of Island No. 65, one from Island 65 to Island 66, and the other from Island 66 to the Minnesota shore, and the heads of these islands had been protected. Since then these dams have been cut down by the ice till their crowns were only 1 foot above low water, permitting a large volume of water to be diverted from the main channel, and about 400 feet of the protection on the head of Island 65 destroyed.

"It was decided the first work to be done was to build two wing dams from the Minnesota shore in such a manner as to throw the current against the lower side of the bar and wash it away. The first Wing Dam, 33 (sheet 18), was built from a point on right bank 1,000 feet above Closing Dam 22 (sheet 18). This dam is 615 feet long, and the crown is 4 feet above low water. Wing Dam 34 (sheet 18), is from a point on shore 750 feet farther up river; it is 300 feet long and the crown also 4 feet above low water. The Closing Dams 21 and 22 (sheet 18), were raised to 4 feet above low water, and the head of Island 65 was again protected. Shortly after the completion of this work, the channel past the head of the island had widened out sufficiently for a whole raft to pass through without difficulty.

"November 10, the fleet was moved up to Fountain City, where, during the season, much trouble was caused the pilots in getting their rafts around the head of the towhead above the steamboat landing. The conditions were almost the same as at Blackbird Island. Three short wing dams were built out from the left bank, above the towhead in such manner as to force a channel straight down the river away from the towhead. Two more wing dams were thrown out from the right bank farther down stream, to hold the channel past the landing at Fountain City. Some slight repairs were made to the shore protection on the towhead, to the shore protection opposite Fountain City, and to Dam 7 (sheet 16).

"December 2. Owing to the river being full of floating ice, the fleet was laid up for the winter in Fountain City Bay, and all work suspended for the season.

List of works constructed and repaired, and of materials used during season of 1890 in vicinity of Fountain City and Wilds Landing, Wisconsin.

Designation.	Dimensions.		Material.	
	Length.	Height above low water of 1864.	Rock.	Brush.
	Feet.	Feet.	Cu. yds.	Cu. yds.
Sheet 16: Closing Dam 7 repaired.....			96.9	106.1
Sheet 17:				
Wing Dam 33.....	615	4.0	1,773.1	2,900.5
Wing Dam 34.....	300	4.0	1,050.1	1,532.0
Wing Dam 35.....	325	4.0	1,567.9	1,647.4
Wing Dam 36.....	275	4.0	937.9	1,718.4
Wing Dam 37.....	145	4.0	676.1	875.4
Wing Dam 38.....	250	4.0	852.0	1,030.1
Wing Dam 39.....	180	3.0	477.2	1,158.9
Closing Dam 22 raised.....	600	4.0	567.8	587.1
Closing Dam 21 raised.....	470	4.0	511.2	456.5
Shore protection, Island 65, repaired.....	400		664.5	280.0
Shore protection, Island 61, repaired.....			48.0	
Shore protection opposite Fountain City repaired.....			61.2	
Sheet 18:				
Closing Dam 2 raised.....	175	4.0	474.3	208.0
Wing Dam 47 raised.....	850	4.5	1,528.2	2,204.3
Total.....			11,286.4	14,795.6

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Financial statement for work in vicinity of Wilds Landing and Fountain City during season of 1890.

Amount expended in the field during the calendar year 1890 (from distribution sheets)	\$17,798.35
Deduct cost of material on hand at close of season.....	452.17
Net cost of field work	17,346.18
Add quota of general superintendence and office expenses	2,730.30
Add for use and deterioration of plant.....	2,493.11
Total cost of work	22,569.59
Material put in work:	
Rock.....cubic yards..	11,286.4
Brush.....do.....	14,795.6
Poles (2,296).....do.....	229.6
Total	26,311.6
Cost of material	\$11,166.81
Average cost per cubic yard on barges.....	\$0.4244
Average cost per cubic yard for towing and putting in material.....	.2349
Average cost per cubic yard for general superintendence and office expenses .....	.1038
Average cost per cubic yard for plant.....	.0948
Average cost per cubic yard in place.....	.8579
* * * * *	

VICINITY OF CROOKED SLOUGH.

A large break having occurred in the dam across Harper Slough, due to the undermining of the soft bank at the island end, it was repaired during June with gravel, furnished by United States dredge *Phoenix*, and rock, purchased at Lynxville. Steam launch *Ada* and the crew of the snag boat *General Barnard* were employed on the work. Cost of rock used was \$937.24.

BUOYS ON ROCK ISLAND RAPIDS.

The buoys were reset April 10 to 15, 1890, by steam launch *Lucia*. There were 30 buoys in the system, 27 of which were secured to the rock bottom by bolts and chains and 3 were held by anchors. During the season, several of the buoys were carried away by rafts but were afterwards replaced.

November 19 to 22, the ranges were adjusted and the buoys were taken up and stored for the winter.

The cost of buoyage for the season of 1890 was \$389.93.

BENCH-MARKS AT ROCK ISLAND RAPIDS.

November 9 to 13 the bench-marks were carefully examined, repainted, and re-numbered, so as to preserve them for future use. Number of bench-marks is 67.

IMPROVING ROCK ISLAND RAPIDS.

This work was in local charge of Mr. J. C. McElherne, superintendent. In the early part of the season Mr. McElherne made very frequent trips over the rapids, for the purpose of ascertaining the views of steamboatmen regarding the improvements already carried out and those proposed. He succeeded in obtaining expressions of opinion from nearly all of the pilots and masters of boats navigating this part of the river. The operations of the season, which commenced August 7 and ended December 6, consisted in the removal of patches of rock at Cabin and St. Louis chains by means of steam-drill and dredge. The proposed work at St. Louis Chain is now completed, that at Cabin Chain nearly so. Some small patches of rock near Duck Creek Chain, broken up in 1889, were removed by dredge. Most of the broken rock taken up by dredge was deposited in Sucker Chute for the purpose of checking the side

draft there, but the small amount gathered at Duck Creek Chain was dumped between the towhead and the Iowa shore.

The plant used consisted of steam drill boat, with powder boat, loading boat, coal flat, and quarter boat, dredge *Ajax*, launch *Louise*, and 5 rock flats. The dredge was taken to Keokuk, November 8, but the rest of the fleet was employed until close of work.

The following extracts are made from Mr. McElherne's report:

"On August 7, operations were commenced by the drill boat at St. Louis Chain, for the purpose of deepening and widening the channel by entirely removing the many dangerous obstructions existing in that locality. In order that blasting might be carried on without interrupting navigation until such a time as a dredge might become available, a section (No. 1), averaging 70 feet wide by 675 feet in length, and occupying the entire length of the extreme Illinois side of the proposed channel excavation, was chosen as the initial work. Points were first established, several holes drilled, and flexible range poles set therein, completely outlining the area in question. The drill boat was then placed at the upper end and on the Illinois side of this section and so maneuvered by means of anchors, lines, and spuds as to operate directly across the section, and at right angles with the current, covering ranges 56 feet wide successively, and, while doing so, making 4 feet moves, thereby securing a careful sounding of the river bottom at each shift made by the boat. Range poles were kept planted, and so regulated on shore as to insure the boat's being properly held on the correct lines. By the time this section was worked over the arrival of dredge *Ajax* left the drill boat free to proceed with the adjoining patch (No. 2). This, together with 3 others, comprising the remainder of the obstructions at St. Louis Chain, were staked out, when reached, and treated according to the same established plan.

"The obstructions met with consisted partly of loose rock and some gravel, but mostly of numerous boulders and solid rock ledges, both large and small, ranging from 0.5 foot to 1.5 feet or 2.0 feet above the grade of 4 feet below low water of 1864.

"The drill boat is provided with two steam drills, mounted on carriages capable of being moved along the gunnel as required. These drills are furnished with steel points, star-shaped, 34 inches in diameter. With them holes were made 4 feet apart in the case of solid patches, if of a size to require them, and bored to a depth of from 18 to 22 inches below grade. The holes were then thoroughly cleaned by means of a water hose, with long nozzle, passing down through a copper tube firmly held in each one. This tube, 3 inches in diameter and of suitable length, has a slot on one side, extending its whole length, to facilitate the escape of debris, and after the charges are rammed securely to the bottom to permit the placing of the wires connecting them. When the loading was finished, the connecting wires were united with the leading wires, thus completing the circuit, and the drill boat was then moved about 50 feet away and the blast fired by electricity.

"The explosive used was dynamite, containing 50 per cent. nitroglycerine, the charges being suitable to the nature and thickness of the rock to be broken.

"October 27, the drill boat finished work on St. Louis Chain. In the accomplishment of this work, she succeeded, after a great deal of laborious shifting, sounding, etc., in shattering all solid formations found projecting above grade, within the entire area, a space averaging 300 feet in width by 600 feet in length.

"As it was definitely known at the close of the work on St. Louis Chain that the dredge would in a very few days be taken away, the drill boat was immediately set at work on Cabin Chain, beginning at the upstream end with a view of selecting and destroying as many as possible of the rock patches already known. The one greatly feared by river men, a compact ledge 4 feet wide, 8 feet long, and 14 inches above grade (on which the steamer *Ben Hershey* and one of our dump boats were sunk), and others of a dangerous type scattered throughout the length of the chain were selected and broken up prior to the departure of the dredge. Subsequently the method of proceeding originally described was pursued and a good portion of the lower end of the chain disposed of; but as it was deemed best not to disrupt the bottom of the channel too much without means at hand of removing the material, and as the windy weather interfered greatly with correct soundings, the boat was moved to the large high patches abreast of pier No. 11. Blasting on these, although well on towards completion, was brought to a close on December 3 by the sudden appearance of heavy floating ice.

"The texture of the rock met with was generally a mixture of sand and limestone, except at the foot of St. Louis and Cabin chains, where it was found to be rather flinty and very hard to drill.

"On August 30, the dredge *Ajax*, having arrived from Keokuk, was set at work at

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downstream end and on Illinois side of Section No. 1, at St. Louis Chain. The material on this section, as well as that on Section 2, was dredged out as soon as possible, the bottom examined, and found to be well down to grade. This gave a clear width of 130 feet, so that, with the aid of a line of large range poles, set in and clearly defining the Illinois edge of the improved channel, all steamboats found ample space to navigate there, thus securing more room and freedom of action for our plant on the unfinished portion of the chain.

"On September 29 the dredge, having caught up with the drill boat, was sent to remove the material blasted last season above Duck Creek Chain. There were four patches there; one, Mason Break, was near Buoy No. 19; the others, of which one was an immense granite boulder on which boats occasionally struck, were in the channel above Buoy No. 20. These having all been found without difficulty and dealt with as intended, the boat was, on October 10, returned to finish up at St. Louis Chain.

"It having happened that the boats were brought too close together for advantageous working, the dredge's time was utilized for a while in trying to procure rock for use in dams along the Illinois shore below Crab Island and below Cabin Chain. Very little was found at the former place, and mostly small boulders at the latter.

"A careful sweeping with iron rail, made after all dredging, having fully demonstrated that the desired end had been attained, the dredge was, on October 29, started on Cabin Chain. In order to make the most of the little time remaining to her, she moved about between the head and foot of Cabin Chain and removed several of the highest patches blasted. She was taken away on November 8, leaving those patches of minor importance, together with the intervening spaces, for future work. Most of the material obtained at St. Louis and Cabin chains was deposited in Sucker Chute for the purpose of shutting off the draft of water, while that taken from patches above Duck Creek Chain was thrown between Duck Creek Tow-head and the Iowa shore on the line of a dam contemplated at that place."

Details of operations.

Launch Louise:	
Hours run	978
Miles run	2, 143
Drill boat:	
Hours worked	912
Hours lost owing to rafts	57
Hours lost owing to accidents	17
Hours lost owing to storms	18
Number of holes drilled	1, 927
Number of holes blasted	1, 879
Average depth of holes, in inches	30
Number of solid cubic yards blasted (approximate)	1, 659
Number of pounds of dynamite used	3, 250
Dredge Ajax:	
Hours worked	546
Hours lost owing to rafts	43
Hours lost owing to accidents	0
Hours lost owing to storms	11
Number of solid cubic yards dredged and removed	2, 119

Financial statement for improvement of Rock Island Rapids for season of 1890.

Amount expended in the field for the calendar year 1890 (from distribution sheets)	\$9, 478. 19
Add quota of general superintendence and office expenses	1, 453. 66
Add for use and deterioration of plant	4, 174. 20
Total cost of work	15, 106. 05
Rock broken up and dredged at St. Louis and Cabin chains, solid cubic yards	
Rock broken up at Cabin Chain, solid cubic yards	1, 398
Rock dredged at St. Louis and Duck Creek chains, solid cubic yards	261
Rock put in dams at Sucker Chute and Duck Creek, cubic yards	721
	2, 119

Allowing \$1 per cubic yard for the rock put in dams, I estimate the cost per solid cubic yard of the rock broken up and dredged at \$7.20; of rock blasted but not dredged, at \$5.24; of rock dredged, at \$1.96.

HARBOR AT LAKE CITY.

Some repairs were made to the pier at Lake City. Details of the work are given in the following report of Superintendent W. A. Thompson:

"This pier was constructed in 1887. Owing to the depth of water being from 20 to 28 feet at low-water stage, for most of the length of the proposed pier, and the small amount of money available for its construction, it was decided to lessen the cost by making a foundation of gravel dredged from the gravel bars in the vicinity of Lake City. After the cribs were put in place a large quantity of gravel was deposited on the outside, to protect the pier from moving ice and the action of the waves.

"On the south side of the pier, and at its outer end, this gravel had settled in 3 years from 3 to 6 feet. Consequently, when the ice broke up in the lake last spring, several of the plank were loosened at their ends, and, during a violent storm in April, 115 of these planks were pulled out and washed away.

"The work of repairing was commenced October 21. The oak plank that were lost were replaced by pine plank 3 inches thick, and all of the other plank on the sloping side were respiked with 7-inch boat spikes.

"An agreement was entered into with Jacob Richtman, of Fountain City, Wis., to place 519.3 cubic yards of rock around the pier in places where the gravel had settled most, at \$1 per cubic yard, and the above-named amount of rock was placed, as agreed, as a protection to the pier foundation. It is believed that this will protect the pier from damages by the ice for another year at least; but I would recommend that a layer of brush and rock be put upon the gravel around the pier to prevent it from sliding out into the deep water.

"This work was suspended November 15.

"The total cost of the repairs was \$870."

* * * * *

SURVEYS AND GAUGES.

Between May 25 and 27 the crew of the *Barnard* made a reconnaissance in vicinity of Reads Landing. On September 24 and 25 an examination of the river in vicinity of Prairie du Chien was made by the same party. Between October 21 and 31 a party, in charge of Superintendent J. C. McElherne, made an accurate survey of the bar at Port Byron. The maps of these surveys have been plotted and used in preparing projects for work. Gauges were kept at Hastings, Red Wing, Prairie du Chien, and Winona during the year. Gauge records were also obtained from the Signal Service and bridge keepers at St. Paul, Dubuque, Rock Island, Keokuk, Burlington, Quincy, Hannibal, and Louisiana. These records are now being plotted.

Amount expended on surveys and gauges during the year was \$745.24.

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, January 12, 1891.

MAJOR: I have the honor to submit the following report of operations, for work in my charge, for the calendar year ending December 31, 1890:

VICINITY OF BURLINGTON AND DALLAS.

I submit extracts from report of Mr. S. Edwards, overseer, on work done at above localities. Mr. Edwards' report is in detail and gives all the necessary figures, which include expenditures to December 31, 1890, and are checked with the office distribution sheets. In the statements it appears that the cost of work done at Dallas, although carried on with a less expensive plant, is slightly in excess of that done at Burlington. This is explained by comparing the comparative amount of rock to brush used at Dallas with the comparative amount used at Burlington. At Dallas there was more than twice as much rock used as brush, while at Burlington the proportion was as nine to eight, or nearly equal quantities. At Dallas the work was mainly

strengthening shore protection that had been only slightly covered with stone, while at Burlington there was the ordinary class of dam and shore-protection work.

I would call attention to Mr. Edwards's figures on the comparative cost of wire and lath yarn for binding purposes. By these it appears that, for making fascines, the lath yarn required for 1 cubic yard will cost, at 10 cents per pound, \$0.023; the wire required for the same purpose, at 3.35 cents per pound, will cost \$0.007, a saving of two-thirds in the cost of binding material by the use of wire instead of lath-yarn. For making into mats, the saving is in the same proportion. The contractors for brush were furnished with wire by the United States. The wire comes in coils that have no covering weighed in, while a considerable portion of the weight of lath-yarn is made up of the packing materials. No. 16 annealed wire is about as small as it is safe to use. The bundles of brush are stronger and stand handling better when bound with wire than when lath-yarn is used, and wire is quite as handy to apply.

List of works constructed and repaired, and of materials used during the season of 1890, in vicinity of Burlington, Iowa, and Dallas, Ill.

Works.	Dimensions.		Material.	
	Length.	Height above low water of 1864.	Rock.	Brush.
	<i>Feet.</i>	<i>Feet.</i>	<i>Cu. yds.</i>	<i>Cu. yds.</i>
Sheet 58:				
Dam 5	340	3.5	1,425.4	1,303.0
Dam 6*	1,230	3.5	2,239.5	2,313.0
Dam 8	640	3.5	2,505.3	2,596.0
Dam 10	320	4.0	515.0	751.9
Shore protection below Drew Prairie	1,940	12.0	2,556.1	1,257.7
Dam 1 repaired			441.2	
Sheet 59:				
Shore protection on Burlington Island repaired	4,600		2,135.9	
Shore protection at Sauerswein Bend repaired	2,700		1,006.4	
Shore protection at Twin Island	196	12.0	343.3	292.0
Sheet 80:				
Dam 14 (not completed)			520.9	1,510.3
Shore protection on Crow Island	980	7.5	1,148.7	697.0
Total			14,837.7	10,720.9

*550 feet of Dam 6 were built for temporary effect, and were removed November 12, 1890.

Rock on hand on bank at close of season of 1890:

Furnished by Rudolph Wiegand, of Nauvoo, Ill., 1,172 cubic yards at 50 cents per cubic yard	\$586.00
Furnished by S. A. Maley, of Pontoosuc, Ill., 350 cubic yards, at 50 cents per cubic yard	175.00
Total	761.00

Financial statement for works of improving Mississippi River in vicinity of Burlington and Dallas, during the season of 1890.

Amount expended in the field during the calendar year 1890 (from distribution sheets)	\$20,646.93
Deduct cost of 1,522 cubic yards of rock on hand	\$761.00
Deduct cost of removing temporary dam	201.77
Deduct cost of survey at Burlington	75.36
Deduct expenses of lawsuit in 1888	138.49
	1,176.62
Net cost of field work	19,470.31
Add quota of general superintendence and office expenses	3,168.19
Add for use and deterioration of plant	3,775.80
Total cost of work	26,414.30
Material put in works:	
Rock	14,837.70
Brush	10,720.90
Total	25,558.60

Average cost per cubic yard on barges.....	\$0.481
Average cost per cubic yard for towing and putting in material.....	.280
Average cost per cubic yard for general superintendence and office expenses.....	.124
Average cost per cubic yard for plant .....	.148

Average cost per cubic yard in place..... 1.033

Mr. Edwards, says: "According to your orders, I left Keokuk September 1, 1890, with steamer *Vizen* and fleet of barges, proceeding to Burlington, Iowa, to build such dams and shore protections as the shortness of the season would allow.

"In vicinity of Burlington, Dams 5, 6, 8, and 10 (sheet 58), were built, and 1,940 feet of shore protection below Drew Prairie (sheet 58) were constructed. Dam 1 (sheet 58) was repaired, after completion of which work the fleet was laid up for the winter, in the Des Moines Rapids Canal, November 15, 1890.

"September 3, 1890, work was commenced on Dam 6 (sheet 58), the second dam on Illinois shore of the seven dams proposed to be built above Burlington, Iowa (see survey completed September 5, 1890). The total length of this dam was 1,280 feet, of which the outer end, 550 feet, was intended as temporary, an apron loaded with only a little rock being put in; the other part, 730 feet long, was built up to 3.5 feet above low water, an average height of 5.5 feet. Navigation at this point, during a low stage of water, has, for a number of years, been more difficult than at any other place in your district, and only a few days before work commenced here boats had been hard aground at this point for as long as 6 hours. By September 10, the 1,280 feet of apron were laid, and September 20 the dam was completed. Scouring commenced immediately after the completion of the apron, and although the river after a small rise, fell as low as 2.3 feet above low water, no difficulties were encountered by any packet or other boat for the balance of the season. The temporary portion of dam was removed by dredging, November 10 to 12, 1890.

"September 20 we commenced on Dam 5 (sheet 58), and completed same September 30. The length of dam is 340 feet; average height is 11.5 feet, and height above low water is 3.5 feet.

"From September 30 to October 18, 1890, a force worked on Dam 8 (sheet 58), the lowest dam of the projected series of four dams on the Illinois side of the river. Owing to the shallow water above Dam 8, a dam could not be built in the position indicated on project for Dam 7 (sheet 58). Dam 8 is 640 feet long, of which length 400 feet are built in 12 feet of water, the balance in 4.5 feet of water, at a 2.5 feet stage, the dam being built up to a height of 3.5 feet above low water. There being too shallow water near shore to float barges, the 400 feet of dam in deep water were built first. After a few days there were 4 feet of water near shore, a scouring of over 2.5 feet, when the remaining 240 feet of dam were built. This dam will prevent an enormous amount of sand from moving into the channel.

"October 18 to November 10, 1890, shore protection below Drew Prairie was constructed. Its length is 1,940 feet, height of bank above low water is 12 feet, and vertical height from bottom averages 21 feet. Though caving fast in some places, especially in windy weather, the bank was very hard and plow and scrapers were used to great advantage in grading the bank, 6 hours' plowing keeping the scraper employed for 18 hours. Where possible to make use of this method, it is a cheap and quick way of grading a hard bank, and, as it was impossible to get men, it enabled me with a very small force to make satisfactory progress.

"In the latter part of October, work was begun on Dam 10 (sheet 58), which is intended, when completed, to extend out from shore of Rush Island opposite Dam 8 (sheet 58) across and beyond the bar abreast of the island. The portion of the dam on channel side of the bar was completed November 15, 1890, and is 320 feet long. The outer end of dam is in 4.5 feet of water, at a 3-foot stage, and inner end 2.5 feet above water surface on the dry bar. I believe this dam will prevent much cutting of the bar, which the building of the other dams would no doubt cause.

"Dam 1 (sheet 58) was repaired by filling with rock a number of holes formed behind the piling, and raising a few places that had settled.

"There remain to be built Dams 7, 9, and 11 (sheet 58), and the inner part of Dam 10 (sheet 58), to close chute behind bar south of Rush Island. These can, however, only be built during high water.

"The work in vicinity of Dallas was commenced October 4 and closed November 8, 1890. Launch *Lucia* and a small force were employed at this work, the *Lucia* taking the men to and from the work and, when the tow was not too long, assisting in towing. The towing of material, owing to the long distance, was mostly done by the steamer *Vizen* during the night. The work in this vicinity consisted in the building of two new pieces of shore protection, at Twin and Crow islands, finishing putting in of apron course of Dam 14 (sheet 60), begun in 1889, and repairing shore protection on Burlington Island and at Sauerwein Bend.

"The length of shore protection repaired on Burlington Island is 4,600 feet. The

length of shore protection at Sauerwein Bend is 2,700 feet, and almost the whole length above the water surface had to be recovered with rock. This piece of work, like the work on Burlington Island, when originally built was, owing to the shortness of funds on hand, only slightly covered, and the action of ice and waves, as well as the caving in of a very sandy bank, had almost left the whole bank uncovered. The apron was found to be in fair condition and no brush was used in repairing two above works.

"New work was done by protecting head of Twin Island (381). The length of shore protection is 196 feet, and the height of bank from bottom of river is 18 feet.

"Lower end of Crow Island (383) was also protected. The length of shore protection is 980 feet and the height of bank above bottom of river is 15.5 feet. This bank contains heavy strata of sand and was caving rapidly, causing, no doubt, much of the trouble below. A long slope was given the bank and I think that, notwithstanding the sandy condition, it will prove a lasting piece of work.

"Dam 14 (sheet 60) was commenced in 1889, but owing to low water its construction had to be discontinued. October 28, 1890, there being water enough to get in, I started party to build same, connecting the apron laid in 1889 with the shore. This apron is 2,540 feet long, of which 200 feet were laid the year before and balance this season. A raising mat 700 feet long was also put in from outer end towards shore. November 5, 1890, work on this dam was again discontinued on account of water falling.

"No difficulties of any consequence were encountered during the season's work outside of the scarcity of men to be had, no doubt due to the lateness of the season in which work commenced.

"Steamer *Vixen* was again run with a double crew, enabling her with ease to do the towing for both works. Some delay was caused by contractors having difficulty in getting men, necessitating the *Vixen's* waiting for material occasionally. At such times she would be employed in snagging, if any such work was necessary.

"A survey was made from the foot of Drew Prairie to Burlington Bridge. No additional help was hired for this work. The survey has been plotted and traced.

"For binding fascines and making mats, wire (No. 16 annealed) was used instead of the customary lath-yarn, and, by its cheapness as well as its quicker handling, recommends itself as far superior to twine."

COMPARISON OF COST BETWEEN WIRE AND TWINE.

From former estimates I get—

For making fascines, per 100 cubic yards, lath-yarn, 32 pounds	\$3.20
For making mats, per 100 cubic yards, lath-yarn, 14 pounds	1.40

100 cubic yards of brush in mats	4.60
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We used this season for 7,120.90 cubic yards brush made into mats 3,630 pounds of wire, at \$3.35 per 100 pounds, or per 100 cubic yards brush in mats	1.70
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A saving per 100 cubic yards of	2.90
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By actual count I find—

10 fascines used 18 ounces lath-yarn, or per 100 cubic yards, 20.45 pounds	2.04
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10 fascines used 19.5 ounces lath-yarn, or per 100 cubic yards, 22.16 pounds	2.16
--	------

1,061 fascines used 241 pounds lath-yarn, or per 100 cubic yards, 22.70 pounds	2.27
--	------

50 fascines used 5.5 pounds wire, or per 100 cubic yards, 20 pounds	0.64
---	------

50 fascines used 5.5 pounds wire, or per 100 cubic yards, 20 pounds	0.67
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Cost of wire per 100 pounds	\$3.20 to \$3.35
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Cost of lath-yarn per 100 pounds	\$10.00 to \$12.00
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"There is no loss in the packing of wire, whereas I have found a loss of 10 per cent. in lath-yarn when taking off the cover and cords.

"Though indebted to a greater part of the force for their ready help, I take particular pleasure in expressing my thanks to Capt. H. B. Whitney, master of steamer *Vixen*, and Mr. George Ackley, receiver of materials, who, by their untiring interest in the work, enabled me to give most of my time to the field work, which I otherwise could not have done." * * *

HARBOR AT BURLINGTON, IOWA.

This work consisted in deepening the river along the levee from lower end of levee at the sewer outlet to the foot of High street. The contractor, under informal agreement of October 18, 1890, was A. J. Whitney. The price paid was 17 cents per cubic

yard removed. Work was begun October 21 and was stopped by the cold weather November 15. The work was not quite completed, but the main and important part was finished. A large gravel bar at the sewer outlet was removed and the levee front deepened to a grade of 5 feet below low water. The work remaining unfinished is dredging from the foot of Court street to the foot of High street, one block, and possibly a narrow cut all along the levee front if found safe to go any nearer the paving.

Financial statement.

Amount paid contractor	\$1,809.69
Cost of local inspection	95.93
Add quota of general superintendence and office expenses	289.56
Total cost of work	2,195.18
 Material dredged and removed, cubic yards	 10,645.2
Average cost per cubic yard	\$0.206

The local inspector was Mr. H. H. Ayres, while Mr. S. Edwards had general supervision of the work.

CARE, REPAIR, AND CONSTRUCTION OF PLANT.

During the year a large amount of repair and construction work was done at the canal dry dock and shops. A coal barge, 100 feet by 20 feet, commenced in 1889, was completed. Considerable work was done on towboat *Fury*, snag boat *J. G. Parke*, towboat *Alert*, and steam launches *Elsie*, *Louise*, *Emily*, *Stella*, and *Ada* received some repairs. Many of the barges and other pieces were put in condition for service, viz: Barges 1, 5, 27, 28, 33, 35, 37, 39, 40, 47, 79, 82, 91, 92, 98, 99, and 105; dump boats 1, 3, and 6; drill boats 34 and 103, and pile-driver 104. At such times as the plant was not used in the field watchmen were employed. Total amount expended for care, repair, and construction of plant during the year was \$9,530.53.

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 1891.

MAJOR: I have the honor to present a preliminary report of operations on the various works in my charge during the second half of the fiscal year ending June 30, 1891:

MINNEAPOLIS TO ST. PAUL.

This work is carried on with a special allotment of \$50,000 in act of September 19, 1890, and under project approved February 28, 1891.

The work projected consists in protecting caving banks, building dams of brush, rock, and gravel, dredging gravel bars, and removing rocks and boulders from channel.

A plant, consisting of steam launch *Emily*, quarter boat 94, working barge 95, rigged with derrick, grapples, sweeping bars, etc., was put in commission June 15, 1891, and proceeded up river from Boulanger Slough, removing a number of boulders from river above Fort Snelling and below Groveland Park. Considerable progress has been made in sweeping the channel between the head of Meeker Island and the Short Line Bridge for the purpose of locating rocks and boulders above grade in that part of the river.

ST. PAUL TO PRESCOTT.

The project allotting \$40,000 for building dams and shore protections, etc., between St. Paul and Prescott was approved February 28, 1891. This work will be carried on by hired labor and Government plant. The condition of this portion of the river is better than has ever before been known for the same stage of water. With one exception the crossings are straight and afford a good depth. At Nininger a bar formed in the channel and caused some trouble, but the dredge *Phoenix*, which oper-

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ated at this point during the month of June, has now opened a good channel, which will be made permanent.

Construction work will be resumed early in July.

READ LANDING TO MINNEISKA.

Work in this locality, consisting of the construction and repair of brush and rock dams and shore protections, is being carried on under contract in accordance with project approved January 6, 1891. The amount of the allotment is \$50,000. Operations commenced May 16, and were carried on continuously until end of fiscal year. The work accomplished is the construction of 3,620 linear feet of shore protection on Island 35; 1,150 linear feet on Island 34, and of closing-dam at Island 34, 750 feet in length. The amount of material put in is, rock, 10,359 cubic yards; brush, 5,968 cubic yards.

MINNEISKA TO LA CROSSE.

The project allotting \$60,000 for building dams, shore protections, etc., between Minneiska and La Crosse was approved February 28, 1891.

Work was commenced, with use of hired labor and Government plant, on June 4, and was carried on until end of fiscal year. There were constructed 1,520 lineal feet of shore protection on Island 49; 200 linear feet of shore protection on Island 50, and Wing dams 8, 9, and 10 (sheet 16). The amount of material put in is, rock, 4,591 cubic yards; brush, 6,704 cubic yards.

VICINITY OF PRAIRIE DU CHIEN.

This work, consisting of the construction of rock and brush dams and shore protections for the improvement of the channel at Prairie du Chien, is carried on by formal contract, under special allotment of \$30,000 in act of September 19, 1890, and under project approved January 8, 1891.

Operations commenced May 25 and were carried on to end of fiscal year. Closing dams 1 and 3 and Wing dams 4, 5, and 6 (sheet 30) were completed. Amount of material put in was: Rock, 4,831.1 cubic yards; brush, 4,762.3 cubic yards.

VICINITY OF CLINTON.

The project allotting \$5,000 for construction of a dam and shore protection in vicinity of Clinton was approved February 28, 1891, and work was carried on, by use of hired labor and Government plant, from May 18 to the close of the year. The work accomplished consisted in the construction of a small dam at the head of the guard fence, East Channel; Dam No. 1, from Island 290 to Willow Island; and shore protection around head of Willow Island. Amount of material put in was: Rock, 2,590 cubic yards; brush, 2,873 cubic yards.

HARBOR AT PORT BYRON.

The act of September 19, 1890, makes a special allotment of \$5,000 for removal of bar at Port Byron, and a project for dredging in that locality was approved February 27, 1891, a modification of which project was approved June 20, 1891.

Work, under agreement with A. J. Whitney, was commenced June 6 and carried on until close of the fiscal year. Amount of material dredged and removed was 9,082 cubic yards.

BUOYS ON ROCK ISLAND RAPIDS.

The buoys having been repaired and repainted were reset April 21 to 24, 1891, by steam launch *Louise*. There are now 29 buoys in the system, all of which are secured by bolts and chains to the rock bottom. All the range stakes were carefully examined, repaired, and painted.

IMPROVING ROCK ISLAND RAPIDS.

Under project approved February 28, 1891, an allotment of \$50,000 was made for excavating and removing rock and sand from the channel of Rock Island Rapids, and for building rock dams and guide piers.

On account of high water the work of rock excavation was not commenced until May 22, and since that time the steam drill has been at work on St. Louis and Cabin chains. As the broken rock has not been taken up by dredge, no estimate can now be given of the quantity. Work on dams and guide piers is not yet begun.

REPAIRS OF PLANT.

During the spring needed repairs were made to towboats *Fury* and *Alert*, steam launches *Stella*, *Louise*, *Ada*, *Emily*, and *Elsie*, and to many of the barges and other pieces of plant pertaining to works above mentioned.

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, July 1, 1891.

MAJOR: I have the honor to present a preliminary report of operations during the second half of the fiscal year ending June 30, 1891:

KEITHSBURG TO MONTROSE.

An allotment of \$60,000 was made for work between Keithsburg and Montrose under project approved February 28, 1891.

It is proposed to carry on the work by use of Government plant and hired labor. Parties are getting out rock at different places, and needed repairs have been made to portions of the plant.

A wrecked ice-barge was removed from the channel near Montrose, during June, by dredge *Ajax* and towboat *Vixen*, and 240 cubic yards of bowlders and gravel were removed from the Devils Island Crossing.

HARBOR AT MONTROSE.

The act of September 19, 1890, made a special allotment of \$2,000 for removal of bar at Montrose, Iowa.

Under project approved February 27, 1891, dredge *Ajax* and towboat *Vixen* worked from June 1 to 26 dredging along the levee, which was cleared of deposits to a depth of 5.5 feet at low water for a length of about 1,000 feet. Eleven thousand four hundred and sixty-five yards of material were removed from the town front.

REPAIR AND CONSTRUCTION OF PLANT.

In the Des Moines Rapids Canal and Dry Dock, extensive repairs were made during the winter and spring to towboats *Fury* and *Vixen*, and minor repairs to other portions of the floating stock.

During the spring a quarter boat, for use in connection with construction of dams and shore protections, was built at the dry dock. The quarter boat was launched June 23, 1891.

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

A A 3.

IMPROVEMENT OF DES MOINES RAPIDS, MISSISSIPPI RIVER.

There was available for this work July 1, 1890, the sum of \$348.14, and the act of Congress approved September 19, 1890, appropriated \$22,000 for completing the work.

At the beginning of the year the work remaining to be done, to complete the work in accordance with the approved project was—the completion of the sluice for carrying off the muddy water brought into the canal by Price Creek, raising the lock walls of the middle lock, the removal of a small amount of rock above grade, the completion of the protection of the canal embankment, and the completion of the lock grounds.

A project for the completion of the laying of 2,500 cubic yards of riprap face stone on canal embankment, at a probable cost of \$4,000, was submitted September 28, 1890, and approved October 6, 1890. This work was completed during the year.

A project for purchasing and laying 2,000 cubic yards of riprap face stone on embankment of canal, at a probable cost of \$7,000, and for raising the lock walls of middle lock, at a probable cost of \$3,420, was submitted December 22, 1890, and approved December 29, 1890. The work of raising the lock walls of middle lock has been virtually completed, and the laying of riprap face stone on canal embankment was continued until the delivery of stone was made impracticable by low water; 818.13 cubic yards of stone were received and laid.

The work remaining to be done under approved project is the removal of a small amount of rock above grade, the completion of sluice at Price Creek, and the completion of the lock grounds and of the protection of canal embankment. It is probable that after this work is carried out, a balance will still be available, which balance can be applied to advantage to the construction of a permanent machine-shop at the lower lock of the canal. The construction of such a shop was referred to in my last annual report.

No further appropriation is required for the completion of this work in accordance with approved project.

Details of the work accomplished are given in the appended report of Mr. M. Meigs, United States civil engineer, in local charge of work.

ABSTRACT OF APPROPRIATIONS.

By act approved—

June 23, 1866	\$200,000
March 2, 1867	500,000
July 25, 1868 (allotment)	300,000
April 10, 1869 (allotment)	178,200
December 23, 1869	200,000
July 11, 1870	400,000
January 18, 1871	341,000
March 3, 1871	250,000
June 10, 1872	400,000
March 3, 1873	400,000
June 23, 1874	400,000
March 3, 1875	480,000
August 14, 1876	230,000
June 18, 1878 (allotment)	62,500
March 3, 1879	25,000
June 14, 1880	20,000
March 3, 1881	25,000

By act passed August 2, 1882	\$30,000
By act approved July 5, 1881	50,000
By act approved August 5, 1886	26,250
By act of August 11, 1888	35,000
By act of September 19, 1890	22,000
Total	4,571,950

Money statement.

July 1, 1890, balance unexpended	\$348.14
Amount appropriated by act approved September 19, 1890	22,000.00
June 30, 1891, amount expended during fiscal year	22,318.14
July 1, 1891, balance unexpended	10,230.99

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, July 1, 1891.

MAJOR: I have the honor to submit the following report on "improving Des Moines Rapids, Mississippi River," for the fiscal year ending June 30, 1891:

RAISING LOCK WALLS AT LOWER LOCK.

The work of raising the lock walls at the lower lock, that was nearly completed at the close of last fiscal year, was finished early in July, 1890; 22.73 cubic yards of face stone and 6.06 cubic yards of backing stone were purchased from Patterson Bros., contractors, for use in this work.

RAISING LOCK WALLS AT MIDDLE LOCK.

In accordance with authority granted, an informal agreement was made with Patterson Bros., owning the Sonora Quarry, to furnish 120 cubic yards of face stone at \$8 per cubic yard, and 100 cubic yards of backing stone at \$3 per cubic yard, for use in raising lock walls at Middle Lock. The prices paid for the stone were the same as those paid under the last formal contract.

The work of raising the lock walls at the Middle Lock was begun April 1, 1891. Derricks were set up for use in unloading and handling the stone. The work was continued until the close of the fiscal year and the raising of the lock walls 3 feet in height is almost complete. The masonry work on the east and west walls is finished. The portion of the wall raised extends 80 feet 3 inches below the upper heel-post and around the upper end of lock to the sluice. All of the lock grounds adjacent to the raised portion of the walls was raised 3 feet with mud dredged from the canal bottom, the mud being covered with 6 inches of black soil taken from the canal lands at Sandusky outside of the embankment. A good deal of the old coping was injured and broken while being taken up, so that the amounts of stone purchased for this work have somewhat overrun the estimated quantities required for the work.

There remain to complete the work a little grading of the grounds and the laying of a small amount of slope wall on the slopes near the towers.

LAYING RIPRAP FACE STONE ON CANAL EMBANKMENT.

During October, November, and a part of December, 1890, and April, May, and the greater part of June, 1891, a force of from 15 to 35 men has been kept employed in laying slope wall on the outside of canal embankment at sections 59 to 65 and sections 79 and 80. The surface covered by slope wall was 6,108.28 square yards.

The stone used in this work was furnished by Patterson Bros., under an informal agreement, the price paid being the same as that under former contract.

On account of the low water which prevailed during the month of June, the towing of stone was impracticable during the latter part of the month. June 22, 1891, at which date the stone that had been delivered had been all put in the slope wall,

the work was discontinued; 818.13 cubic yards of riprap face stone had been delivered up to the time of closing the work. A partial payment was made on 300 cubic yards of stone piled at quarry, the stone to be delivered as soon as the stage of water warranted putting a tow boat at work transporting it.

OFFICE BUILDING AT LOWER LOCK.

Electric-light fixtures were put up at the office building, connection for lighting the building by electricity being made with the lower-lock dynamo. The lights were used during a number of nights in the spring of 1891. They worked well and are perfectly satisfactory.

The road about the office building was graded.

I have been ably assisted in the above work by Messrs. S. Edwards and John R. Carpenter, overseers, and by Mr. O. S. Willey, clerk and draftsman.

Very respectfully, your obedient servant,

M. MEIGS.
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

A A 4.

OPERATING AND CARE OF DES MOINES RAPIDS CANAL AND DRY DOCK.

The Des Moines Rapids Canal was open for navigation during the year 234 days, during which time there passed through it 878 steamboats and 357 barges, carrying 15,801 passengers, 45,217 tons of merchandise, and 364,878 bushels of grain. There also passed through the canal 193,358,089 feet of lumber, 37,176,150 feet of logs, 87,259,690 shingles, and 59,350,595 laths.

The expenses of operating and caring for the Des Moines Rapids Canal, including extensive repairs to guard gates, during the past year have been \$44,998.20. These expenses are now provided for by an indefinite appropriation made by act of Congress of March 3, 1881.

The machine shops and storerooms now in use at the lower lock of the canal are old frame structures, liable, together with their valuable contents, to destruction by fire. It is desirable that a stone or brick structure be built as a part of the permanent lock buildings. It is estimated that such a building will cost \$3,500, and a project for its construction will soon be presented. As the construction of such building is made necessary, in part at least, by the repairs required in connection with operating and care of canal, it appears proper that a portion of its cost should be borne by the indefinite appropriation for the canal, and \$1,000 is therefore added to the estimate of funds required for next fiscal year.

A thorough examination of the lower lock should be made during the coming year, and some repairs to gates, culverts, etc., will certainly be required. The cost of the work which may be found necessary can not be closely estimated, but is approximately given in the estimate for the coming year as \$4,000.

The amount of dredging which it has appeared practicable to carry out during past few years has not been sufficient to keep pace with the filling, and it is desirable that a large amount of dredging be carried out during coming season. The item in estimate of probable expense of dredging is therefore increased.

The appropriation for the dry dock was exhausted in 1889, completing the work in accordance with approved project. Since that time the dock has been operated as a part of the Des Moines Rapids Canal,

in accordance with instructions of the Secretary of War and the river and harbor act of September 19, 1890, which provided as follows:

SEC. 14. That the dry-dock constructed at the Des Moines Rapids Canal under the provisions of the acts of Congress approved August second, eighteen hundred and eighty-two, July fifth, eighteen hundred and eighty-four, August fifth, eighteen hundred and eighty-six, and August eleventh, eighteen hundred and eighty-eight, shall be considered an integral part of the Des Moines Rapids Canal, and the act of Congress approved March third, eighteen hundred and eighty-one, which provides for expenses of operating and care of Des Moines Rapids and other canals, and the act of Congress approved July fifth, eighteen hundred and eighty-four, which provides penalties for violation of rules and regulations prescribed by the Secretary of War, shall also apply to the said dry-dock.

During the past year the dock has been almost constantly in use. A table showing boats using the dock is appended. One hundred and twelve dollars and fifty cents, dockage fees, were collected from private parties using the dock, and deposited in the United States Treasury to the credit of the Treasurer of the United States. It is desirable, when appropriations are available and circumstances permit, that a shop with wood-working machinery and storage sheds for lumber be provided at the lower end of the dock. The expenses of operating the canal will be slightly increased by the operating of the dry dock as an accessory work; but it is hoped such increase will be more than offset by the increased facility furnished for repair of Government boats and the amounts received from private parties for the use of the dock. There is appended hereto a history of the dry dock construction.

The boom, constructed in accordance with act of Congress, for connecting outer wall of the canal with the pier of the Keokuk and Hamilton Bridge, requires repairs, and must be taken into the canal at the close of navigation and put out again in the spring. An item for the expense of such repair and labor is included in estimate of cost of operating and caring for canal for the coming fiscal year.

Tables are given herewith showing details of expenditure and traffic. A table giving dates of opening and closing of canal and of the highest and lowest stage of water for each year since the canal was opened to navigation, and comparative expenditure and traffic statements are also submitted.

The operating and care of the canal and dock are in the immediate charge of Mr. M. Meigs, United States civil engineer, whose report is appended.

ABSTRACT OF APPROPRIATIONS.

By act approved:	
April 30, 1878	\$7,500.00
June 18, 1878 (allotment)	32,500.00
March 3, 1879	40,000.00
June 14, 1880	30,000.00
March 3, 1881, for fiscal year ending:	
June 30, 1882	45,000.00
June 30, 1883	75,000.00
June 30, 1884	47,000.00
June 30, 1885	40,500.00
June 30, 1886	43,000.00
June 30, 1887	44,000.00
June 30, 1888	42,000.00
June 30, 1889	39,000.00
June 30, 1890	43,837.97
June 30, 1891	43,965.80
Total	573,333.77

Money statement.

July 1, 1890, balance on hand	\$1,004. 20
June 30, 1891, amount drawn from Treasury under indefinite appropriation	43,995. 80
	<hr/> 45,000. 00
June 30, 1891, amount expended during fiscal year	44,998. 20
	<hr/>
June 30, 1891, balance on hand	1. 80

HISTORY OF THE DRY-DOCK CONSTRUCTION AT THE DES MOINES RAPIDS CANAL.

The construction of a dry dock at the Des Moines Rapids of the Mississippi River was under consideration by private parties as early as 1868, and in 1877 certain plans were prepared, but no further action was taken at that time.

A Board of Engineer Officers, constituted by orders of the Secretary of War March 13, 1879, for consideration of the feasibility of utilizing the water power of the Des Moines Rapids Canal, submitted a report in which the subject of a dry dock is referred to as follows:

"In reference to the dry dock the Board is of the opinion that such a work, in connection with the canal, would be of great value to commerce. The amount of water required for this purpose would have no appreciable effect on the canal. The location mentioned by Mr. Jenne is the most favorable for such a work. A dry dock is needed by the Government for the repair of the boats, dredges, barges, scows, etc., in use on the canal, and numerous Government vessels employed on the Western rivers in that vicinity. The dock should be built by the Government, and be open for general use at rates to be prescribed by the honorable Secretary of War, and under such regulations as he may prescribe. As the proper care and maintenance of the river bank of the canal is essential to its existence, under no circumstances should the absolute control of it, and all openings through it, pass out of the hands of the Government."

A resolution of the House of Representatives of the United States, dated March 30, 1882, requested the Secretary of War "to furnish the House with any information in his possession concerning the need of a Government dry dock at the Des Moines Rapids Canal, on the Mississippi River, together with the views of the Department upon the subject."

Under date of April 11, 1882, a report upon the subject-matter of the above-mentioned resolution was submitted to the Chief of Engineers by Captain A. Mackenzie, Corps of Engineers. This report recited as follows:

"The Upper Mississippi River is navigable during a large portion of the year for the largest class of steamers from St. Paul to the mouth of the Missouri, a distance of over 700 miles. There is no dry dock in this stretch of river; and to make repairs upon hulls, steamers and barges must be hauled out upon ways. These ways are few in number, and none of them are suitable for the repairs of the largest steamers.

"A dry dock is much needed in the interests of commerce, and its construction is of importance.

"The most favorable point for establishing a dry dock is at Keokuk, Iowa, where, by building as an adjunct to the canal, the cost of construction and operating can be reduced to the lowest figure consistent with good work.

"Such a dry dock connected with the canal can not, without endangering the interests of navigation, be constructed or operated by private interests, but if the management of the dock is in the hands of the Government, as is the management of the canal, no interference is possible.

"The United States now owns and uses, in connection with the improvement of the Upper Mississippi, large fleets of towboats, barges, dredges, etc. It is desirable to make Keokuk a depot for repairs and construction, and in connection with such work a dry dock would be most convenient and would materially reduce the cost of repairs which must now be made on private ways." * * *

The views expressed in this report were approved by the Chief of Engineers April 18, 1882, and by the Secretary of War April 19, 1882.

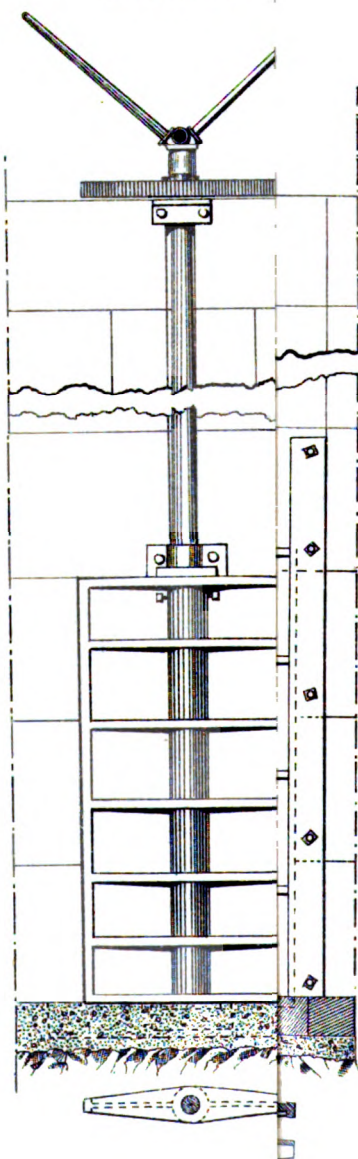
The act of Congress passed August 2, 1882, provided for the commencement of a dry dock, as follows:

"That the sum of thirty thousand dollars, or so much thereof as may be necessary, be, and the same is hereby, appropriated for the construction of a dry dock at the Des Moines Rapids Canal on the Mississippi River, at such site as may be selected thereon by the Secretary of War; said dry dock to be used for the construction,

SLIDING GATE.

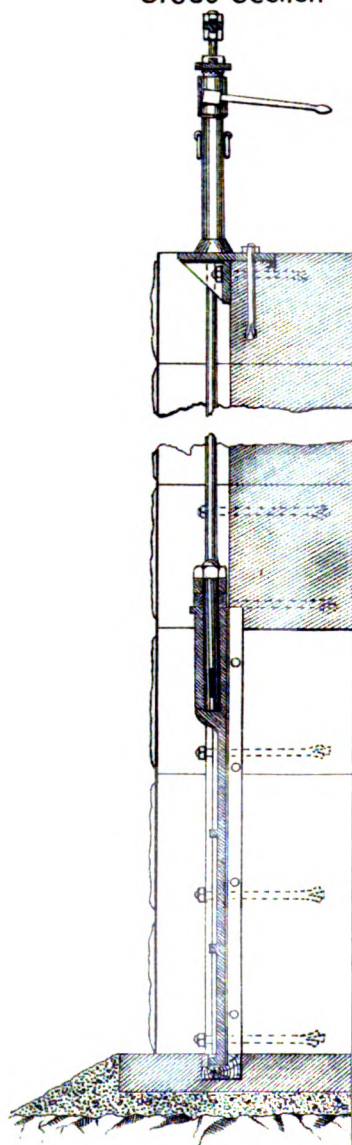
BALA

Elevation.



8 feet

Cross-Section



examination, repairing, and use of boats, dredges, barges, scows, and other vessels of the United States, and the construction, examination, and repair of vessels for private parties, under such regulations and for such compensation as may, from time to time, be fixed and regulated by the Secretary of War; this appropriation to be expended under the direction of the Secretary of War."

Additional appropriations were provided as follows: By act approved July 5, 1884, \$30,000; by act approved August 5, 1886, \$48,750; by act of August 11, 1888, \$16,250; making the total appropriations by Congress for the work, \$125,000.

A project for the construction of the dry dock was submitted to the Chief of Engineers by Maj. A. Mackenzie, Corps of Engineers, September 12, 1882, and approved by the Secretary of War in February, 1883.

Preliminary work was begun in April, 1883, and the actual construction of the embankment in the following July. Work on the dock was carried forward as rapidly as appropriations permitted and virtually completed in August, 1889, at a total cost of \$133,000, of which amount \$125,000 were appropriated by Congress for construction of dry dock, and \$8,000 were allotted from appropriations for improving Des Moines Rapids and for operating and care of Des Moines Rapids Canal, for work which pertained to canal embankment and sluices as well as to the dry dock. Materials, such as stone, iron, cement, and timber, were purchased under formal contract, and all work was done by day's labor.

The dock is situated on a low piece of ground belonging to the United States on the river side of the canal embankment and just above the middle lock. As constructed, it furnishes a basin 400 feet long and 100 feet wide, with entrance from the canal through gates giving an opening of 80 feet, which is the same width of opening as is furnished by the canal locks. The outer embankment is of clay, protected by riprap face stone. At the lower end of the dock ground for shops and storage of lumber is provided. The abutments of gates and sluices are of cut-stone masonry. The bottom of dock is formed of gravel resting on solid rock and covered with paving stone, with suitable timber supports founded on rock for carrying boats. Drainage is provided for, according to the stage of water, by sluices through outer embankment by a drain emptying into middle level of canal and by pumps.

The dock since completion, and even for a time before, has been in use almost continuously by the United States for the repair and construction of plant connected with the improvement of the Upper Mississippi River and by private parties for emergency work. It has served admirably the purpose for which it was constructed. The largest boats can be docked safely in a comparatively short space of time with steam up and without removing cargo, affording opportunities for frequent examinations and for minor repairs which would probably not be undertaken at any of the private boatyards on the river, where considerable time is consumed in hauling out and launching boats.

The detailed plans for this dock were prepared by Mr. M. Meigs, U. S. civil engineer, assisted by S. Edwards and O. S. Willey. The construction was also carried on under Mr. Meigs' immediate supervision, the masonry work being in charge of Mr. John Carpenter, the woodwork under charge of Mr. Hans Martens, and the earth work under charge of Mr. James Sullivan.

From the reports of Mr. Meigs the following detailed descriptions of portions of the dock are prepared. Further details and dimensions are shown in the three accompanying drawings.

Dry-dock embankment (Sheet No. 1).—The inner or west side of dock is formed by the canal embankment; the outer or river embankment is of earth, with a puddle wall 4 feet wide and resting on the rock, which was found at an average depth of 7 feet below the natural soil. All sod and natural soil was removed to a depth of 1 foot before commencing embankment. The earth was taken from a clay bank west of the canal; dump cars, running by gravity from the pit onto barges, were ferried across the canal and transferred to the track. The embankment is protected outside and inside by a paving of riprap face stone averaging 15 inches in thickness.

Bottom of dock (Sheet No. 1).—The natural soil, which covered the ledge rock to a depth of about 7 feet being unfitted for a bottom for dock, was removed, partly by wagons and scrapers, which deposited the material on a terrace at the foot of the dock, and partly by dredges. Gravel was then dredged from the river and dumped in the dock, forming a perfect foundation for the riprap face stone paving with which it is covered. The grillage for carrying the boats consists of 8 longitudinal stringers, each 400 feet long, resting on concrete walls 30 inches deep and 24 inches wide at the bottom; the timbers are bolted to the concrete walls at intervals of 6 feet; cross timbers, toggled together so as to be removable, rest upon the longitudinal timbers at intervals of 16 feet, making a flat bed for boats to rest on 400 feet long and 50 feet wide. The grillage and bottom of dock are built on a slope of 8 feet in 400 towards the entrance of the dock. A tile drain under the floor at the foot of the inner slope intercepts all leakage through the canal embankment.

Head gates (Sheet No. 2).—The head gates of the dock are of simple construction. The keel post, vertical posts, and diagonal rods of the gates, and the hollow quoin, are

of iron; the arms are of oak; the sheathing is of 3-inch cypress, tongued and grooved, put on diagonally. This sheathing is placed on the lower or lock side of the gates, thus preventing any great lifting effect when the dock is empty, and adding to the life of the arms by keeping all but two upper arms constantly submerged, and these two upper arms can be readily replaced without interfering with use of dock. There is no miter post proper, the arms abutting against a 4-inch plank. As the gates are not to be used often, hand-power is considered sufficient. By capstans and the arrangement of chains shown three men can swing a gate in about 8 minutes. By means of pivots 10 inches in diameter, at top of the heel posts, collars, iron castings on the coping of abutment, and anchoring rods, the gates are suspended without the aid of columns, and no rollers are used. Notwithstanding the length of gates as compared with their height, their construction gives them sufficient stiffness to permit of swinging them without any appreciable settlement of outer end and when the water is out of the canal and dock. The coping stones are fastened down by one-quarter-inch bolts of various lengths up to 8 feet.

Filling and emptying culverts, drains, and pumps (Sheet No. 3).—The dry dock is filled through a cut-stone masonry culvert behind the eastern or river-side gate of the dock. This culvert is 7 feet wide and 8 feet high, with arched roof; connection with the canal is through four openings, each 3 feet wide and 5 feet 10 inches high. The culvert discharges into a sump at the upper end of the dock, with its bottom 4 feet lower than lowest part of dock proper. This sump drains into the river through four openings similar to those at inlet of culvert. The openings for filling and discharge are closed by cast-iron gates which slide vertically. These gates are raised by a hydraulic jack of 7 tons capacity, working against a crosshead connected by keys with two vertical $1\frac{1}{2}$ -inch rods, to lower end of which rods is attached the gate. When the ram has made one lift of 18 inches the ram and crosshead are run down, the keys are inserted at a new place on the vertical rods, and another lift is made. Four lifts raise a gate to its full height. To hold the gate during the shifting of crosshead a clamp is provided. The hydraulic jack is on a truck and is moved from one gate to another. When pressure is on the gates 2 men can raise a gate quickly, the work being about equal to the capacity of the jack. After putting the dock in operation it was found that, at times when a boat was not taking the blocks properly, a more rapid closing of the outlet than was practicable with the sliding gate was necessary, and two balanced gates were added to the outlets. These balanced gates are of cast-iron on a vertical stem $3\frac{1}{4}$ inches in diameter, and are operated from the top of the wall by small capstan heads and gear wheels, increasing power in ratio of 7 to 1. Capstan bars 5 feet long are used. This arrangement works very satisfactorily and rapidly. The culverts and gates are so arranged as to also furnish a sluiceway for the muddy water coming into the canal from Price Creek.

The direct drainage into the river is practicable up to a stage of 6 feet above low water on the lower lock river gauge. Above this stage and up to a stage of 12.1 feet on same gauge the drainage is through a 15-inch tile drain, which passes under the floor of the dock from the sump to the culvert of the middle lock. On the line of this drain is provided a well with two self-acting valves which prevent back flow into the dock when the middle lock is filled or discharging into the canal when the dock fills. Either or both valves can be opened by means of chains.

At certain stages of the river it is necessary to depend upon pumps for drainage. A 12-inch rotary pump located on a well house in the south wall of the sluice is provided.

REGULATIONS FOR THE USE OF THE DRY DOCK AT THE DES MOINES RAPIDS CANAL.

1. The dry dock at the Des Moines Rapids Canal will be considered as a part of the Des Moines Rapids Canal and its use will be governed by the regulations for the government of this canal approved by the Secretary of War April 14, 1885, so far as they may be applicable to the use of the dry dock, and by the following special regulations:

2. The penalties provided for by section 7 of the river and harbor act of July 5, 1884, and published with the canal regulations, will apply to all violations of general or special regulations governing the use of the dry dock.

3. The dry dock at the Des Moines Rapids Canal, when not required for repairs (construction by the United States, may be used by private parties or corporation under certain restrictions and under the supervision and direction of the United States officer or agent in charge of the Des Moines Rapids Canal.

4. The use of the Des Moines Rapids Canal Dry Dock being primarily for the construction, examination, and repair of Government property, and it being imperative that this dock be so managed as to be at all times available at short notice for the use of the Government, it is necessary to restrict the use of the dock by private parties to such time as is required for making repairs in emergencies and for such work

as can not, in the opinion of the United States officer or agent in charge of the Des Moines Rapids Canal, be conveniently or properly carried out at private boat yards.

5. Private parties desiring to use the Des Moines Rapids Canal Dry Dock will give notice to the United States officer or agent in charge of the Des Moines Rapids Canal as long in advance as practicable, stating when use of dock is wanted, nature of repairs required, and the dimensions and character of boat. No boat will enter the dock until the permission of the United States officer or agent in charge has been obtained.

6. All private parties or corporations using the Des Moines Rapids Canal Dry Dock will furnish all material and labor required for prompt execution of their work, and will also furnish all labor for properly operating, under the immediate personal supervision of an authorized canal employé, gates, sluices, and other machinery and appliances of the dry dock. No gate, sluice, or other machinery or appliance of the dry dock will be operated or in any way meddled with except by permission of and under the personal supervision of such authorized canal employé.

7. No boat will be allowed to occupy the Des Moines Rapids Canal Dry Dock for a longer period than 2 days when other boats are waiting to use the dock, except in cases when, in the opinion of the United States officer or agent in charge of the Des Moines Rapids Canal, circumstances necessitate and justify a longer use than 2 days. The United States officer or agent in charge of the Des Moines Rapids Canal is authorized to remove from the dry dock any boat using or occupying such dock without his authority, and the expense of such removal will be paid by the party or parties owning such boat.

8. The wages of all mechanics and laborers, due from private parties for repairs carried on in the Des Moines Rapids Canal Dry Dock, must be paid before the boat leaves the dock.

9. The Government charges for the authorized and necessary use and occupancy of the Des Moines Rapids Canal Dry Dock by private boats shall be, until further orders, as follows:

For boats of less than 200 tons:

For first day of 24 hours, or part thereof.....	\$15.00
For each subsequent one-fourth day, or part thereof	3.75

For boats over 200 tons and less than 500 tons:

For first day of 24 hours, or part thereof.....	20.00
For each subsequent one-fourth day, or part thereof	5.00

For boats over 500 tons:

For first day of 24 hours, or part thereof.....	25.00
For each subsequent one-fourth day, or part thereof	6.25

10. The charges for all use or occupancy of the Des Moines Rapids Canal Dry Dock by a boat of private parties, after repairs on such boat have, in the opinion of the United States officer or agent in charge of the Des Moines Rapids Canal, been so far completed as to permit safe removal from the dock, or after such removal has been ordered by the United States officer or agent in charge of the Des Moines Rapids Canal, shall be \$50 per day or part of a day, in addition to any penalties incurred for violation of any of the regulations prescribed by law for the government of the dock and those using it.

11. The dock will be considered in use by a boat from the time the dock is placed at its disposal until the boat is out of the dock.

12. Registered tonnage shall be taken when it is available. In other cases the tonnage will be computed by the United States officer or agent in charge of the Des Moines Rapids Canal.

13. The charges for the use of the dry dock must be paid at the time the boat leaves the dock.

2180 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

List of vessels docked at the dry dock at the Des Moines Rapid Canal during the fiscal year ending June 30, 1891.

Designation.	Date of entering dock.	Date of leaving dock.	Designation.	Date of entering dock.	Date of leaving dock.
Steamers:			Quarter boats:		
Lily, (U. S. light-house tender)	July 18, 1890	July 19, 1890	No. 91	Nov. 20, 1890	Apr. 6, 1891
Julia*	Aug. 8, 1890	Aug. 10, 1890	No. 92	do	Dec. 4, 1890
Alert	Aug. 16, 1890	Aug. 23, 1890	No. 118†	do	June 23, 1891
Colonel Patterson*	Sept. 11, 1890	Sept. 15, 1890	Grasshoppers:		
J. G. Parke	Oct. 9, 1890	Oct. 15, 1890	No. 113	Sept. 15, 1890	Sept. 20, 1890
Fury	Nov. 20, 1890	May 1, 1891	No. 112	Apr. 18, 1891	May 1, 1891
Vixon	Apr. 1, 1891	Apr. 18, 1891	No. 113	May 1, 1891	May 4, 1891
J. G. Parke	May 1, 1891	May 4, 1891	Barges:		
Fury	May 4, 1891	May 6, 1891	No. 98	July 19, 1890	July 29, 1890
Thistle*	May 8, 1891	May 9, 1891	No. 7	Aug. 23, 1890	Sept. 6, 1890
General Barnard	May 11, 1891	May 14, 1891	No. 79	Aug. 26, 1890	Aug. 30, 1890
Steam launches:			No. 40	do	do
Lucia	Aug. 13, 1890	Aug. 16, 1890	No. 35	Aug. 30, 1890	Sept. 6, 1890
Stella	Nov. 20, 1890	June 13, 1891	No. 32	Sept. 6, 1890	Sept. 11, 1890
Elsie	Apr. 18, 1891	May 1, 1891	No. 29	do	do
Dredges:			No. 83	Sept. 20, 1890	Sept. 23, 1890
Phoenix	July 8, 1890	July 12, 1890	No. 33	do	Oct. 8, 1890
Phoenix	Aug. 11, 1890	Aug. 13, 1890	No. 31	do	Sept. 23, 1890
Ajax	Nov. 13, 1890	Nov. 15, 1890	No. 28	do	Oct. 8, 1890
Ajax	Apr. 6, 1891	Apr. 18, 1891	No. 82	Oct. 25, 1890	do
Pile driver:			No. 39	do	do
No. 104	Nov. 10, 1890	Nov. 13, 1890	No. 37	do	do
Drill boat:			No. 5	do	do
No. 34	June 13, 1891	June 16, 1891	No. 79	Apr. 18, 1891	May 1, 1891
Dump boats:			No. 63	May 4, 1891	May 8, 1891
No. 5	July 8, 1890	Aug. 23, 1890	No. 6	do	May 11, 1891
No. 6	July 29, 1890	Nov. 10, 1890	No. 1	do	do
No. 1	Aug. 25, 1890	Sept. 6, 1890	No. 67	May 6, 1891	do
No. 2	Sept. 15, 1890	Sept. 20, 1890	No. 99	May 20, 1891	June 2, 1891
No. 1	do	do	No. 4*	May 22, 1891	May 23, 1891
No. 3	Nov. 10, 1890	Nov. 20, 1890	No. 98	June 2, 1891	June 13, 1891
No. 5	May 20, 1891	do			

*Belongs to private parties.

† New; built at dry dock.

Expenditures for operating and care of Des Moines Rapids Canal for fiscal year ending June 30, 1891.

Month.	Office and administration.				Canal and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Current repairs.	Total.
1890.								
July		\$2. 75	\$21. 44	\$24. 19		\$54. 68	\$757. 44	\$812. 12
August	\$1,025. 00	30. 06	28. 19	1,083. 25	\$2,864. 50	329. 68	1,389. 37	4,583. 55
September	375. 00	86. 65	-----	461. 65	1,645. 17	892. 32	641. 65	3,179. 14
October	375. 00	5. 00	-----	380. 00	1,710. 99	147. 87	667. 20	2,526. 06
November	375. 00	1. 50	21. 44	397. 94	1,631. 42	222. 70	947. 50	2,801. 71
December	375. 00	-----	4. 15	379. 15	1,596. 33	131. 25	2,426. 14	4,152. 72
1891.								
January							1,381. 13	1,381. 13
February	1,150. 00	13. 90	-----	1,163. 90	2,915. 00	136. 02	2,237. 55	5,268. 57
March	375. 00	-----	16. 00	391. 00	1,502. 50	248. 64	586. 16	2,337. 30
April	375. 00	7. 30	21. 44	403. 74	1,585. 16	43. 54	406. 67	2,035. 37
May	375. 00	15. 00	-----	390. 00	1,715. 00	153. 48	223. 39	2,091. 88
June	375. 00	-----	0. 72	375. 72	1,620. 66	365. 08	200. 02	2,185. 76
Total	5,175. 00	162. 76	113. 38	5,451. 14	18,785. 73	2,725. 27	11,863. 31	33,374. 31

Expenditures for operating and care of Des Moines Rapids Canal, etc.—Continued.

Month.	Dredging canal.				Grand total.
	Labor.	Supplies.	Current repairs.	Total.	
1890.					
July		\$162.87	\$4.00	\$166.87	\$1,003.18
August	\$2,642.50	962.00	109.24	3,683.74	9,350.54
September		872.76	89.66	462.42	4,103.21
October			50.88	50.88	2,957.54
November			28.32	28.32	3,237.97
December .....			.95	.95	4,532.82
1891.					
January					1,381.18
February			46.26	46.26	6,498.72
March			36.12	36.12	2,764.42
April		22.68	171.14	199.82	2,638.93
May	\$21.01	219.04	146.30	1,286.35	3,767.23
June		191.28	9.75	201.03	2,762.51
Total	3,563.51	1,906.63	702.61	6,172.75	44,998.20

Traffic statement of the Des Moines Rapids Canal for the fiscal year ending June 30, 1891.

Month.	Boats up.	Boats down.	Barges up and down.	Passengers.	Merchandise.	Grain.
1890.						
July	103	60	65	5,904	Tons. 14,823	Bushels. 51,450
August	71	67	48	3,637	3,774	29,255
September	59	58	20	1,104	2,645	74,140
October	60	51	32	288	3,364	33,562
November	32	23	25	13	750	7,000
1891.						
April	38	9	35	75	3,517	3,375
May	88	37	73	909	11,351	98,399
June	63	59	59	3,871	4,993	67,697
Total	514	364	357	15,801	45,217	364,878

Month.	Lumber.	Logs.	Shingles.	Laths.	Lockage at one lock.
1890.					
July	Feet. 12,102,764	Feet. 1,500,000	Number. 4,075,750	Number. 3,469,595	234
August	35,637,375	6,990,000	13,824,500	8,776,465	322
September	54,572,321	9,280,000	26,269,750	17,039,385	372
October	35,794,960	6,371,150	16,153,500	11,743,995	302
November	8,775,000	4,000,000	3,680,000	2,550,000	112
1891.					
April	900,000				81
May	2,068,000	1,000,000		1,000,000	157
June	43,507,639	8,085,000	23,256,190	14,771,155	215
Total	193,358,089	37,176,150	87,250,000	50,350,595	1,895

2182 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Comparative expenditures of operating and care of Des Moines Rapids canal for fiscal years 1882-1891.

Year.	Office and administration.				Canals and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Repairs.	Total.
1882....	\$3,710.00	\$161.69	\$550.62	\$4,422.31	\$21,122.70	\$1,654.06	\$1,946.03	\$24,722.79
1883....	4,821.12	289.86	449.52	5,560.50	25,813.49	2,216.87	3,203.01	31,233.28
1884....	6,045.22	209.12	665.62	6,919.96	17,654.23	4,344.51	1,291.20	23,289.94
1885....	6,015.00	245.41	573.88	6,834.19	17,615.97	1,965.92	5,237.89	24,849.77
1886....	5,225.00	209.12	432.10	5,866.22	17,731.76	2,226.23	5,652.87	25,610.86
1887....	4,875.00	85.19	424.48	4,884.67	18,326.23	2,752.80	3,775.59	24,854.62
1888....	4,870.00	154.04	481.70	5,505.74	16,892.82	1,942.94	3,972.29	26,808.05
1889....	3,750.00	26.80	318.82	4,095.62	17,241.79	2,277.97	2,689.20	23,208.96
1890....	4,425.00	120.84	238.08	4,783.87	18,245.07	2,376.55	7,848.88	28,470.50
1891....	5,175.00	162.76	113.38	5,451.14	18,785.73	2,725.27	11,863.31	33,374.31

Year.	Dredging canal.					Miscellaneous.	Grand total.
	Labor.	Supplies.	Repairs.	Contract.	Total.		
1882.....	\$2,340.43	\$572.09	\$46.58	\$14,080.39	\$17,839.49	\$68.75	\$47,053.34
1883.....	4,765.93	1,538.80	598.04	30,666.17	37,568.94	3,564.77	77,926.70
1884.....	7,485.45	4,789.32	1,262.02	.....	13,536.79	536.73	43,283.42
1885.....	3,353.12	8,580.69	1,883.73	.....	13,822.54	.....	44,506.50
1886.....	4,081.55	3,017.49	3,530.41	.....	11,532.45	.....	43,009.53
1887.....	6,149.45	3,810.12	2,453.98	.....	12,413.55	.....	42,152.84
1888.....	5,084.77	2,267.62	1,808.85	.....	9,161.24	1,327.32	42,802.35
1889.....	5,573.56	3,528.06	2,479.17	.....	11,580.79	.....	38,885.37
1890.....	3,196.58	1,260.78	6,284.07	.....	10,741.43	.....	43,995.80
1891.....	3,563.51	1,906.63	702.61	.....	6,172.75	.....	44,998.20

Comparative traffic statement showing the total traffic that has passed through the canal since its opening in 1877, by fiscal years ending June 30.

Fiscal year.	Steam-boats.	Barges.	Passengers.	Merchandise.	Grain.	Lumber.	Logs.	Laths.	Shingles.	Lockage at one lock.
				Tons.	Bushels.	Feet.	Feet.	Number.	Number.	
1878.....	670	548	.....	53,340	737,415	25,000,000	4,000,000	3,700,000	.....	824
1879.....	802	454	5,008	64,658	2,192,642	33,347,612	8,086,000	8,721,796	11,749,000	1,564
1880.....	967	651	13,231	78,989	2,197,469	21,832,478	13,160,960	27,863,640	30,561,000	2,497
1881.....	840	276	10,003	44,962	1,154,092	52,256,235	11,013,410	11,657,655	15,091,000	1,339
1882.....	760	444	8,588	29,043	781,817	17,150,011	4,475,000	3,112,825	4,885,250	2,292
1883.....	1,107	705	9,192	43,359	729,174	13,093,325	1,040,000	11,558,000	4,435,000	1,353
1884.....	913	245	13,057	54,215	470,580	57,018,151	9,399,784	15,924,645	25,182,250	1,908
1885.....	889	169	13,065	54,120	776,432	43,119,797	2,779,670	13,473,205	25,018,750	1,270
1886.....	784	218	22,221	56,001	465,681	22,769,823	3,195,360	4,302,800	8,253,000	755
1887.....	990	318	20,797	52,815	366,432	178,754,876	24,827,000	19,961,781	90,450,922	1,717
1888.....	595	235	8,330	33,180	143,037	166,827,752	34,506,000	83,642,450	49,848,840	1,749
1889.....	1,022	288	22,880	50,008	381,559	118,508,045	26,333,320	50,221,099	37,413,810	1,941
1890.....	924	477	14,529	71,453	397,788	146,078,329	26,689,300	44,316,167	73,540,370	1,827
1891.....	878	357	15,801	45,217	364,878	193,358,089	37,176,150	59,350,595	87,259,690	1,895

Dates of opening and closing of canal for all years since its opening to navigation.

Year.	Canal opened.	Canal closed.	River opened.	River closed.	Highest water.		Lowest water.	
					Date.	Feet.	Date.	Feet.
1877.....	Aug. 22	Dec. 10	Feb. 17	Dec. 10	Feb. —	20.55	Sept. —	0.65
1878.....	Mar. 8	Nov. 28	Open.	Dec. 20	June 11	12.05	Sept. 22	1.45
1879.....	Mar. 17	Dec. 9	Mar. 6	Dec. 28	June 2	8.45	Oct. 4	1.00
1880.....	Mar. 8	Nov. 19	Jan. 5	Dec. 8	June 29	17.50	Aug. 24	2.05
1881.....	Apr. 16	Oct. 17	Mar. 25	No close.	Oct. 29	18.95	Aug. 29	2.75
1882.....	Mar. 6	Nov. 25	Open.	Dec. 15	Apr. 25	15.90	Oct. 5	2.65
1883.....	Apr. 13	Dec. 6	Mar. 1	Dec. 27	May 8	15.45	Sept. 22	2.10
1884.....	Apr. 1	Nov. 23	Mar. 15	Dec. 30	Mar. 31	16.80	Aug. 25	2.80
1885.....	Apr. 1	Nov. 24	Mar. 14	Dec. 14	Mar. 15	12.80	Nov. 30	3.40
1886.....	Apr. 1	Nov. 21	Mar. 15	Dec. 2	May 6	15.95	Dec. 1	0.50
1887.....	Mar. 28	Nov. 23	Feb. 11	Dec. 21	Feb. 12	11.60	Nov. 28	0.00
1888.....	Mar. 29	Nov. 22	Mar. 1	No close.	May 16	19.65	Dec. 26	-0.80
1889.....	Mar. 18	Nov. 23	Mar. 8	Feb. 24	Feb. 26	10.75	Dec. 5	-0.70
1890.....	Apr. 1	Nov. 20	Jan. 28	Jan. 21	June 30	12.60	Jan. 8	-2.46
1891.....	Apr. 1	.....	Open.	.....	.....	.....	.....	.....

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, July 1, 1891.

MAJOR: I have the honor to submit the following report on "operating and care of Des Moines Rapids Canal" for the fiscal year ending June 30, 1891:

The canal was open to navigation 234 days and closed 131 days. Navigation closed November 20, 1890, and opened April 1, 1891.

The low-water periods of the past fiscal year extended from July 20 to November 20, 1890, and from May 29 to June 30, 1891, during which times the guard-lock gates of the canal remained open to the river and nearly all navigation necessarily made use of the canal.

REPAIRS TO CANAL EMBANKMENT.

Very little work was done on the canal embankment. One or two small leaks were stopped and the riprap repaired. Quite a serious leak has developed just above the middle lock in the old embankment between the canal and the dry dock that will soon require attention, though at present giving no cause for uneasiness.

REPAIRS TO LOCKS, LOCK GROUNDS, ETC.

At the guard lock heavy repairs were made to all of the four gates. A cofferdam 14 feet high, 12 feet wide, and 94 feet long was built above the lock, and one 6 feet high by 4 feet wide below. The material for the dam was all dredged by the canal dredge *Ajax*, either from the river just above the canal, the material being gravel and clay, or stiff mud dredged from the canal bottom. Both dams stood very well and gave but little trouble. At the upper gates the six upper arms and sheathing were removed, and at the lower gates four tiers of arms were removed. In planking the gates anew, the planks, being of 3-inch cypress, tongued and grooved, were planed on the lower face of the gates. There was also some work done in taking up the old cast-iron segments at the upper end and in filling in between the stone blocks to which they were bolted with wood, forming a support for the gate should any accident happen to the suspension rods. Similar blocking was put in behind the segments at the lower end of the lock; also new sheaves, hoods, and sheave-frames, the hoods being of a much stronger pattern than the old ones. Culvert frames were repaired where found necessary, and everything put in good order. New clevises of a new pattern and cast of aluminum bronze were put in all the gates of the canal. There were two qualities made—those for the larger gates of bronze No. 1 (containing 10 per cent. of aluminum), and those for the four upper gates at middle and lower locks of bronze No. 2 (containing 5 per cent. of aluminum). The latter clevises proved deficient in strength. Tests of the metal showed a tensile strength of 77,000 pounds per square inch on small specimens cut from the casting.

The repairs of the guard-lock gates, etc., were carried on from November 29, 1890, to February 9, 1891. A mild winter greatly facilitated this work.

At the middle and lower locks black soil was spread over the lock grounds and grass seed was sown upon the graded surface. Curbing was laid around the office building at the lower lock and stone posts, with chains, put up.

At the middle and guard locks a mason was employed to trim off sharp corners of the lock walls, replace defective stones, and point up the joints of the masonry.

The telephone line was rebuilt from the middle lock to the guard lock in September, 1890. Lightning rods were put up on every fourth pole to protect the line, which is very much exposed, from injury during thunderstorms. New telephone cables were put in at the crossings of the canal. The old cables had given out completely.

REPAIRS TO PLANT.

A large amount of repair work was done to boats and barges of the canal. Dredge *Ajax* was docked from April 7 to 30, 1891. New leaders were put in her front, crane castings were replaced, and 6 iron knees were substituted for the wooden ones about her leaders. A spud of dredge was repaired and general repairs were made to dredge machinery. The towboat *Pixie* was docked and four broken timbers in bottom of boat replaced.

BOOM BELOW LOWER LOCK.

The boom was taken in November 15, 1890, without trouble, and stored in the canal for the winter. It was put out again April 1 and 2, 1891. This boom should be docked over winter, and the accumulated mud washed out of it at the dry dock. It begins to float very low in the water. It has answered its purpose thoroughly and gives general satisfaction.

MACHINE SHOP AT LOWER LOCK.

During the winter all but one of the lock engineers were employed on general lock and machinery repairs. New clevises of aluminum bronze were made for all the canal gates, and new pins were made for the clevises. Dynamos were repaired and electric machinery was overhauled. A relief valve was made and fitted to the lower lock distributing valve. At least \$40,000 worth of work has now been turned out of this shop since it was inaugurated in 1883, and nearly all of this is a direct saving to the United States.

CAPSTANS AT LOCKS.

A worm capstan, built by the American Ship Windlass Company, of Providence, R. I., was erected at the middle lock. This capstan and the one at the lower lock are principally used for hauling rafts into and out of the locks, and are of great service in expediting the passage of the locks.

DREDGING CANAL.

Dredge *Ajax* and towboat *Vixen* were employed in dredging canal from July 1 to August 25, 1890. At the latter date the dredge was detached for work at Rock Island and Rapids. Dredge *Ajax* was employed November 20 to 25, 1890, in dredging material for cofferdams at the guard lock; March 28, to April 6, 1891, in removing guard lock cofferdams, dredging material for filling the middle-lock grounds, putting out boom at lower lock, etc.; May 4 to 31, 1891, in removing deposits of mud from the upper level. Dredge *Phoenix*, with steam-launch *Ada* as tender, worked in the upper level of the canal from August 1 to 10, 1890. At the latter date the *Phoenix* went to Montrose to remove some cribs that obstructed the raft channel.

Material removed:

Vicinity of guard lock.....	cubic yards..	23,667.64
Vicinity of Sandusky.....	do.....	22,612.19
Vicinity of lower lock.....	do.....	490.93

Total		46,770.76
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DEPOSIT IN THE CANAL.

A survey was made of the whole canal in August, 1890, and the amount of deposit above grade calculated therefrom. The survey shows that extensive areas of the canal are 2 feet above grade, and some portions even 3 feet above grade.

OFFICE BUILDING.

The new office building has been in use for one year. The past very mild winter showed that by use of stoves it would be difficult to keep the building warm in severe weather. It should be heated by steam from the boiler at the lower lock. Estimates made place the expense of this work at \$650.

OPERATING DRY DOCK AT DES MOINES RAPIDS CANAL.

The dry dock has been in constant use during the past year for the docking and repairing of boats belonging to the Government plant, as well as of boats belonging to private parties, the latter being permitted to use the dry dock under the regulations for the use of the dock that have been approved by the Secretary of War.

During the year private boats and barges were docked for repairs, and dockage fees for such use of the dry dock and at the rates approved by the Secretary of War were collected as follows:

Steamer <i>Julia</i>	\$30.00
Steamer <i>Colonel Patterson</i>	52.50
Steamer <i>Thistle</i>	15.00
Barge No. 4 (towed by steamer <i>Musser</i>)	15.00

Total	112.50
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There should be a proper shed built at the dry dock for storing oak and other lumber, and for protecting the workmen from the weather during winter work. A proper shed can be built for \$2,500, and about \$500 additional would purchase some machinery—a saw and a planer, which are much needed at times.

The addition of the dry dock to the appurtenances of the Des Moines Rapids Canal requires the expenditure of a small sum annually to keep it in repair and in use. One dockmaster and one watchman are required at the dry dock continuously. More or less incidental repairs have to be made annually to the buildings and grounds of the dock. I estimate that the sum required annually to keep the dry dock in operation is as follows:

One dockmaster and carpenter, 12 months, at \$100 per month.....	\$1, 200
One watchman, 12 months, at \$45 per month	540
Supplies	200
Miscellaneous repairs to buildings and grounds	300
Total	2, 240

BUSINESS OF THE CANAL.

Low water set in about the middle of July, 1890, and continued until the close of navigation. In 1891 low water began May 29, and continued until the close of the fiscal year. Of the 8 months during the year that the canal was operated, 5 months were marked by low water; and during this season of low water nearly all navigation was necessarily through the canal. Heavy tows of ice and railroad ties have been features of the commercial statistics.

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

A A 5.

PRELIMINARY EXAMINATION OF SLOUGH AT HAMILTON, ILLINOIS, WITH
A VIEW TO DREDGING OUT THE SAME.

[Printed in House Ex. Doc. No. 72, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 6, 1890.

SIR: I have the honor to submit herewith the accompanying copy of report, dated November 25, 1890, from Maj. A. Mackenzie, Corps of Engineers, giving results of preliminary examination of slough at Hamilton, Ill., with a view to dredging out the same, made to comply with provisions of the river and harbor act approved September 19, 1890.

Major Mackenzie reports that an examination of this locality was made under the act of August 11, 1888, and an adverse report made thereon under date of November 27, 1888, to be found on pages 1781 to 1784, Annual Report Chief of Engineers for 1889; and that after a second personal examination of the locality he is still of the opinion that the main slough at Hamilton, Ill., is not worthy of improvement by the General Government, an opinion which is also held by Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division. The views of these officers are concurred in by me.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

HON. REDFIELD PROCTOR,
Secretary of War.

REPORT OF MAJOR A. MACKENZIE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., November 25, 1890.

GENERAL: The river and harbor act of September 19, 1890, provided for an examination or survey of the slough at Hamilton, with a view to dredging out the same.

The preliminary examination of the main slough at Hamilton, Ill., assigned to me by letter dated Office Chief of Engineers, September 25, 1890, having been made, I have the honor to submit the following report thereon:

The river and harbor act of August 11, 1888, provided for an examination of "Mississippi River, the main slough at Hamilton, Ill., to the end of securing a good and sufficient landing at that point." A report upon such examination was submitted by me to the Chief of Engineers under date of November 27, 1888, and is found on pages 1781-1784, Report of the Chief of Engineers for 1889. A sketch of the locality and copies of letters received from the Business Men's Association of Hamilton accompanied the report. Considering the interests involved, the natural condition of the slough, and the section of the Mississippi River in its vicinity, and the very great expense that would attend the carrying out of such work as was contemplated by the act of Congress, my conclusions, as given in former report, were that the main slough at Hamilton was not worthy of improvement by the General Government.

The conditions now existing in Hamilton Slough are the same as existed at time of the former examination. The head of the slough is obliterated, except at high stages, by a gravel bar, which is constantly increasing in size; water only reaches the slough in an insignificant stream, through a narrow and crooked cut-off; several creeks empty into the slough at and above the town of Hamilton, forming gravel bars, which stretch across and, in places, almost fill the entire bed of the slough, which bars, if removed, would soon reform; at and below the town of Hamilton the slough is crossed by low highway and railway bridges without draw openings.

The former head of the slough and the existing cut-off can only be made accessible from the main river at stages of less than 3 feet, even for small steamboats and light-draft flatboats, by extensive rock cutting in the bed of the Des Moines Rapids and of the slough, in addition to sand and gravel dredging in river and slough.

It is practicable by the dredging of some sand and gravel to enlarge and straighten the cut-off and increase somewhat the depth of water in the slough, and such work, so long as its effects remained, would probably enable very light-draft boats and barges to reach the town during a portion of the year, and the lumber yards of Hamilton and local shipping interests would derive some benefit from such dredging; but the existing conditions and public necessity would not, in my opinion, justify the undertaking of such temporary work by the General Government.

For further details regarding the subject under consideration, I would refer to my former report of November 27, 1888.

After a second personal examination of the locality I am still of the opinion that the main slough at Hamilton, Ill., is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

A. MACKENZIE,
Major, Corps of Engineers.

[Second indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., December 3, 1890.

Respectfully returned to the Office of the Chief of Engineers with report that I concur in the opinion of Major Mackenzie that the locality referred to is not worthy of improvement by the General Government.

O. M. POE,
*Colonel, Corps of Engineers,
 Division Engineer, Northwest Division.*

A A 6.

[Printed in House Ex. Doc. No. 135, Fifty-first Congress, second session.]

PRELIMINARY EXAMINATION OF MISSISSIPPI RIVER AT AND ABOVE CLINTON, IOWA, WITH VIEW OF REMOVING BARS NORTH OF LITTLE ROCK ISLAND.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., September 27, 1890.

GENERAL: I have the honor to acknowledge the receipt of letter dated Office Chief of Engineers, September 20, 1890, referring to preliminary examinations required by river and harbor act of September 19, 1890, assigning to my charge a preliminary examination of "Mississippi River at and above Clinton, Iowa, with view of removing bars north of Little Rock Island," and allotting \$50 for the cost of such preliminary examination.

The locality referred to embraces a portion of the Upper Mississippi River between Fulton, Ill., and Clinton, Iowa, about 2 miles in length. All the facts regarding this piece of river which would be shown by a preliminary examination are fully known to me, and, from information at hand, I am able to submit the following report:

The section of the Upper Mississippi River being considered contains much sand, and portions of the channel are changeable. A sand bar has, during the past few years, been moving down towards the head of Little Rock Island, and now, at certain stages of water, interferes somewhat with raft navigation.

The conditions of navigation above Clinton are not such as to make immediate work in that locality of as much importance as work on other portions of the Upper Mississippi River, but it certainly appears that the section of the river being considered is worthy of improvement, and that such improvement should be carried out whenever funds can be properly allotted to the work. Any work which may be carried out between Fulton and Clinton will form a part of the "improvement of the Upper Mississippi River," an improvement in which the whole commerce of the Mississippi River is interested.

As no detailed survey of the section of river under consideration has been made for several years, I believe a new survey is justifiable and desirable. The cost of such a survey, including office work of making maps, I estimate to be \$300, or \$250 in addition to the \$50 allotted for preliminary examination.

Very respectfully, your obedient servant,

A. MACKENZIE,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, September 29, 1890.

Respectfully forwarded, approved and recommended.

O. M. POE,
*Colonel, Corps of Engineers,
 Division Engineer, Northwest Division.*

SURVEY OF MISSISSIPPI RIVER AT AND ABOVE CLINTON, IOWA, WITH
 VIEW OF REMOVING BARS NORTH OF LITTLE ROCK ISLAND.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., December 20, 1890.

GENERAL: The river and harbor act approved September 19, 1890, provided for a preliminary examination of the "Mississippi River at and above Clinton, Iowa, with a view of removing bars north of Little Rock Island." It was further provided by the act that, if such preliminary examination showed the locality to be worthy of improvement by the General Government, a survey should be made and estimates of the cost of proper improvement should be prepared.

By letter dated September 20, 1890, the preliminary examination above referred to was assigned to me, and, under date of September 27, 1890, I submitted a report upon such preliminary examination. In this report I stated:

The section of the Upper Mississippi River being considered contains much sand, and portions of the channel are changeable. A sand bar has, during the past few years, been moving down toward the head of Little Rock Island, and now, at certain stages of water, interferes somewhat with raft navigation.

The conditions of navigation above Clinton are not such as to make immediate work in that locality of as much importance as work on other portions of the Upper Mississippi River, but it certainly appears that the section of the river being considered is worthy of improvement, and that such improvement should be carried out whenever funds can be properly allotted to the work. Any work which may be carried out between Fulton and Clinton will form a part of the "improvement of the Upper Mississippi River," an improvement in which the whole commerce of the Mississippi River is interested.

As no detailed survey of the section of river under consideration has been made for several years, I believe a new survey is justifiable and desirable.

The survey above referred to was ordered by letter, dated Office Chief of Engineers, October 1, 1890, and made in October, 1890. A tracing showing the results of the survey is transmitted herewith.*

This survey shows that at the present time there exists a deep, wide channel in the center of river and along the Illinois shore from Fulton to the head of Little Rock Island; at this point the main low-water channel crosses the head of the island, under a sand bar, to the Iowa shore. At any stage packets and single towboats experience little or no trouble in the vicinity of Clinton, so far as the depth and shape of the channel is concerned. At stages greater than 4 feet above low water rafts are sent down the Illinois shore east of the island, under the raft span of the railroad bridge. When the water is at a lower stage rafts must follow the low-water channel across the head of Little Rock Island and pass the bridge west of the island, and this operation is tedious and attended with some danger.

* Not reprinted.

The difficulties of raft navigation at and near Clinton, while due partially to the condition of channels at the islands, are due mainly to the existence of the railroad bridge. This bridge, built many years ago without consideration of plans by the War Department, is a most serious obstruction to navigation. It is not provided with a draw on the east side of the river, and the openings on the west side are inadequate. The main troubles to which navigation is subjected at this bridge can only be remedied by the virtual rebuilding of the bridge.

If the low-water channel could be made to follow the Iowa shore without closing the Illinois channel, a more favorable approach to the draw of the bridge could be secured. Appearances indicate that this result will be accomplished in time by the natural action of the river. A channel along the Iowa shore, together with a new and enlarged draw span, would do away with most of the trouble now experienced at Clinton; but it is not practicable to put in any works at the present time which would interfere with the Illinois channel without materially affecting the raft interests.

A careful study of the river in its present condition indicates to me that any work of improvement in the river above the head of Little Rock Island should be postponed until the natural conditions for improvement are more favorable, and possibly until some further action is taken in connection with the rebuilding of the Clinton railroad bridge. In this opinion I am supported by the Brotherhood of Upper Mississippi River Pilots, who, at their annual meeting held at Clinton, Iowa, December 2-5, 1890, resolved that no work above Little Rock Island is, at the present time, necessary or desirable.

The channel between Little Rock Island and the towhead to its left has been increasing in depth of late, which partially accounts for the making down of the bar on the head of the island. It is advisable to close this channel, and such work is called for by the navigators of the river.

Notwithstanding the troubles attending the passage of rafts through the raft span of the railroad bridge down the Illinois shore, which passage necessitates the letting go of rafts and the taking of towboat around the islands through the draw of the bridge, this east channel is used when stage of water permits, it being practicable to pass larger rafts than can be taken on west side of island. This east channel, besides having no draw, is now obstructed at certain low stages by piling, rock, gravel, and the remains of an old pier. The railroad company have expressed the intention of removing these obstructions before next spring. Below the bridge it is desirable that the channel be somewhat improved, and a few wing dams from the Illinois shore are considered necessary; but such work, while indicated by broken red lines on the tracing, being below Clinton and having no reference to the removal of bars above Little Rock Island, can not well be considered in detail in this report.

The only work which appears advisable or necessary at the present time in connection with the removal of bars above the island is a closing dam between Little Rock Island and the towhead to its left. Such a dam is indicated by full red line on the tracing, its location being possibly subject to some change at time of construction. This dam would be built to a height of about 5 feet above low water and its cost is estimated to be \$5,000.

As stated in my preliminary report, this locality is a part of the Upper Mississippi River, for the improvement of which an appropriation is provided, and while the locality is certainly worthy of improvement at

the proper time, there are no conditions which necessitate a special appropriation for the work. All necessary work in this locality can be carried out, whenever found necessary, under allotments from the general appropriation for "improving the Mississippi River from Minneapolis to Des Moines Rapids."

Very respectfully, your obedient servant,

A. MACKENZIE,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.
(Through Col. O. M. Poe, Corps of Engineers, Division Engineer,
Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, December 23, 1890.

Respectfully forwarded.

I concur in the conclusions reached by Major Mackenzie in this report, and recommend that his proposition to build "a closing dam between Little Rock Island and the towhead to the left" be approved.

O. M. POE,
Colonel, Corps of Engineers,
Division Engineer, Northwest Division.

APPENDIX B B.

IMPROVEMENT OF MISSISSIPPI RIVER ABOVE FALLS OF ST. ANTHONY, MINNESOTA, OF CHIPPEWA RIVER, WISCONSIN, OF ST. CROIX RIVER, WISCONSIN AND MINNESOTA, OF MINNESOTA RIVER, MINNESOTA, AND OF RED RIVER OF THE NORTH, MINNESOTA AND NORTH DAKOTA; GAUGING MISSISSIPPI RIVER AT OR NEAR ST. PAUL, MINNESOTA.

REPORT OF MAJOR W. A. JONES, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|---|---|
| 1. Mississippi River above Falls of St. Anthony, Minnesota. | 5. Minnesota River, Minnesota. |
| 2. Reservoirs at headwaters of Mississippi River. | 6. Red River of the North, Minnesota and North Dakota. |
| 3. Chippewa River, including Yellow Banks, Wisconsin. | 7. Surveys for reservoirs at the sources of Mississippi, St. Croix, Chippewa, and Wisconsin rivers. |
| 4. St. Croix River, Wisconsin and Minnesota. | 8. Gauging Mississippi River at or near St. Paul, Minnesota. |

EXAMINATIONS.

- | | |
|---|---|
| 9. Harbor at Hudson, Wisconsin, with a view to prevent the city being cut off from the navigable channel of the St. Croix Lake, as a result of the Government dike now constructed at that point, and with a view to the feasibility of conducting the waters of Willow River past the city of Hudson into the navigable channel of the lake. | and Minnesota, with a view of improving the navigation of the same by the construction of a lock and dam at Goose Rapids in said river. |
| 10. Red River of the North, North Dakota | 11. Creel Bay, Totten Bay, and Minnauken Shoals, in Devil Lake, North Dakota, with an estimate of the cost of improving the same by dredging or otherwise, so as to re-establish the navigation of said lake. |

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., July 8, 1891.

GENERAL: I have the honor to transmit herewith reports upon the surveys and works for improvement of rivers and harbors in my charge for the fiscal year ending June 30, 1891.

Very respectfully, your obedient servant,

W. A. JONES,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

B B 1.

IMPROVEMENT OF MISSISSIPPI RIVER ABOVE FALLS OF ST. ANTHONY,
MINNESOTA.

The present project, under which work has been carried on since and including 1880, is based upon the project for the improvement of 217 miles of the river, from Conradi Shoals to Grand Rapids, the latter the present head of steamboat navigation. The estimated cost, \$54,127.50, is given in the report of February 8, 1875, upon part of the Mississippi routes to the seaboard; plan of improvement to afford 3 to 5 feet depth in the channel by removing snags, bowlders, and bars, and confining the low-water discharge to widths practicable for navigation by means of wing dams where necessary. In 1889 the estimate was increased to \$63,000.

This same report (1875) estimated the cost of improvement of the river between the Falls of St. Anthony and St. Cloud at \$144,667.50; the improvement of this section to afford 5 feet depth in the channel at low water between the falls and St. Cloud by removal of sand, gravel, and bowlder bars and the construction of wing dams. The sum of \$20,000, appropriated by act of Congress approved August 14, 1876, was expended between those places. Prior to the rendition of the report and estimate of February 8, 1875, Congress had appropriated, by act approved June 23, 1874, the sum of \$25,000 for improvement of the river above the Falls of St. Anthony, which was also expended in improving the channel between the falls and St. Cloud.

Steamboat navigation having discontinued between the falls and St. Cloud, a distance of 78 miles, the third appropriation made by Congress, that of \$15,000, by act of Congress approved June 14, 1880, was applied to the stretch (130½ miles in length) of river between Aitkin and Grand Rapids (this stretch included within the distance from the rapids to Conradi Shoals), as have been all subsequent appropriations for improving the river above the Falls of St. Anthony.

Before work of improvement commenced under the present plan the stream between Aitkin and Grand Rapids was so obstructed by snags, bowlders, and leaning trees that at low and even high stages of water navigation was difficult and sometimes almost impossible for steamers drawing less than 3 feet of water.

The amount expended on present project to June 30, 1890, including outstanding liabilities, \$44,960.13. With this sum there had been produced a general depth in the improved channels except on the rapids of 3 feet at low water. On the rapids the channel depths were but 2 feet; a few snags and leaning trees offered some obstruction, but did not seriously interfere with navigation.

Field work during the past fiscal year was performed between November, 1890, and April, 1891, in deepening and widening all the shoal places (rapids) in the channel between Aitkin and Brainerd. The work was carried on during the winter, as at that season the water could be brought by the aid of the reservoirs at headwaters of the Mississippi River to an abnormally low stage and offered the best opportunity for prosecuting work.

The following is a statement of work performed during the fiscal year ending June 30, 1891:

Description.	Quantity.	Cost.
Wing and training dams constructed (1,403 feet long):		
Rock placed in work.....cu. yds..	696½	\$2.99 per cubic yard.
Brush placed in work.....cords..	168	\$4.99 per cord.
Boulders removed from channel.....cu. yds..	957	\$3.27 per cubic yard.
Clay, sand, and gravel reefs excavated.....do....	554	\$6.27 per cubic yard.
Snags removed:		
16-inch diameter.....	1	
18-inch diameter.....	1	
32-inch diameter.....	1	

The field work was in charge of Mr. R. Davenport, assistant engineer, to whom credit is due for energy displayed. His report, appended hereto, contains an account in detail of the season's operations.

During the month of August a steamboat will be employed in removing all snags which obstruct the channel, and then the work of improving this stretch of river will be completed. Our operations during the last winter were extremely successful, and resulted in making a good navigable river from Grand Rapids to Brainerd, a distance of 185.4 miles. Over this reach we have increased the navigable depth more than 1 foot.

There being no demand at present for navigation between Brainerd and Minneapolis, no further appropriation is now asked for. The time will come when this should be done. I will say in conclusion that this reach may be placed in excellent navigable condition at quite a reasonable expense.

Amount expended during fiscal year ending June 30, 1891, including outstanding liabilities, \$10,479.22.

The three completed reservoirs at the headwaters of the Mississippi River, above Grand Rapids, may be relied upon henceforth to provide sufficient water and depth for the steamboats on the river at and above Aitkin.

Last season one steamer with barges was engaged in freight and passenger transportation between Aitkin and Grand Rapids. During the winter of 1889-'90 the Duluth and Winnipeg Railway Company constructed and are now operating a line from Cloquet, a point on the St. Paul and Duluth Railway, to Grand Rapids. The same company will extend their line from Grand Rapids toward Winnipeg.

In 1889, my predecessor, Maj. C. J. Allen, reported—

"The comparative tables of commercial statistics herewith show that in 1880, the year in which the work of improvement between Aitkin and Grand Rapids commenced, there was but one steamer (with its barges) plying between those points, and that though the amount of freight transported that year by steamer was unusually large, the freight rates were from 75 cents to \$1 per hundred pounds, while in 1883, 1884, 1885, and 1886 the rates reduced to 20 to 40 cents per hundred pounds. The last named figures obtained in 1886, at which time there were three steamboats engaged in freighting and carrying passengers between Aitkin and Grand Rapids. The country bordering the river north of Aitkin is becoming more and more settled, and there is no doubt that the improvement of the river already effected by the United States Government has largely contributed to the increase in settlement."

This work is in the collection district of Minnesota, of which St. Paul is the port of entry and St. Vincent a subport. Collections for year ending December 31, 1890, \$305,878.60. Value of domestic exports for same period, \$1,733,907.

2194 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

ABSTRACT OF APPROPRIATIONS.

By act approved—	
June 23, 1874.....	*\$25, 000
August 14, 1876.....	*20, 000
June 14, 1880.....	15, 000
March 3, 1881.....	10, 000
By act passed August 2, 1882.....	10, 000
By act of August 11, 1888.....	10, 000
By act approved September 19, 1890.....	18, 000
Total	108, 000

Money statement.

July 1, 1890, balance unexpended	\$43. 54
Amount appropriated by act approved September 19, 1890.....	18, 000. 00
	18, 043. 54
June 30, 1891, amount expended during fiscal year	10, 451. 27
July 1, 1891, balance unexpended.....	7, 592. 27
July 1, 1891, outstanding liabilities.....	31. 62
July 1, 1891, balance available	7, 560. 65

REPORT OF MR. R. DAVENPORT, ASSISTANT ENGINEER.

ST. PAUL, MINN., April 30, 1891.

MAJOR: The following report of work done in the improvement of the Mississippi River above the Falls of St. Anthony, during the winter of 1890-'91, is respectfully submitted.

The work was commenced in November, 1890, and completed in April, 1891, just before the opening of navigation. During the entire working season the river was closed by ice.

The force employed on the work consisted in all of 14 men and 2 teams, extra teams being hired when occasion—moving camp, etc.—required.

The men and teams were housed in tents—the camp being moved as often as necessary—so as to be always in the immediate vicinity of the work.

The length of river worked over was about 165 miles, from Grand Rapids to a point 3 miles below the outlet of Pine River. Of this distance, however, about 15 miles between Aitkin and Pine Knoll required no work of improvement, as on that section the river is deep and sluggish and free from bowlders and reefs.

The work of improvement, as instructed, was confined entirely to the removal of obstructions from the navigable channel, and the construction of wing and training dams where necessary.

All obstructions were removed to an estimated depth of 3 feet below low water (1,000 cubic feet per second discharge from Pokegama Dam) and to a minimum width of 80 feet at the same stage.

Bowlders of all sizes up to 3 cubic yards were removed by horse-power, aided by blocks and tackle. Clay, sand, and gravel reefs were excavated by scrapers, rakes, and shovels, after first being broken up by dynamite. (Seven hundred pounds of dynamite were used on the work.)

In all 957 cubic yards of bowlders and 564 cubic yards of clay, sand, and gravel reefs were removed from the channel.

Length of wing and training dams and shore protection constructed, 1,409 linear feet.

Brush cut, bound into fascines, and placed in dams, 168 cords. Rock collected and placed in dams, 696½ cubic yards. Snags removed from channel, 3.

The cost of the work averaged as follows:

Removal of bowlders and excavation of clay, sand, and gravel reefs, per cubic yard.....	\$3. 27
Brush cut, bound into fascines, and placed in dams, per cord.....	4. 99
Stone excavated or collected from reefs and placed in dams, per cubic yard..	2. 98½
Snags removed, each.....	6. 66½
Cost of subsistence, per ration.....	.358
Cost of forage, per ration.....	.419

* Made and expended before the adoption of the present project.

INTER OF

ub. Yds.

low low water.



d.



The following is a statement of the work in detail:

Locality.	Boulders re- moved from channel.	Clay, sand, and gravel reefs excavated.	Length of wing dams con- structed.	Length of shore protection constructed.	Brush placed in dams.	Rock placed in dams.	Snags removed.		
							Number.	Diameter.	Length.
	<i>Cu. yds.</i>	<i>Cu. yds.</i>	<i>Lin. ft.</i>	<i>Lin. ft.</i>	<i>Cords.</i>	<i>Cu. yds.</i>		<i>Inches.</i>	<i>Feet.</i>
Grand Rapids	16								
Grand Rapids to Potters Chute, 1 mile	4								
Potters Chute	77	66							
Potters Chute to Hales Rapids, 15 miles	13								
Hales Rapids	70½	9	60	30	4	76			
Hales Rapids to Pine Rapids, 43 miles	20½						1	18	60
Pine Rapids	102	51	201	70	24	131			
Pine Rapids to Crooked Rapids, 5 miles							1	32	50
Crooked Rapids	106	111							
Crooked Rapids to Bat- sons Reef, 5 miles	9½								
Batson's Reef	23½	7	80		17½	46½			
Ox Portage Rapids	11	17							
Ox Portage Rapids and Noyes Rips, 2 miles	6½	27	185	55	32	128			
Noyes Rips	44	27	60						
Noyes Rips and Sandy Lake Rapids, 10 miles	19								
Sandy Lake Rapids	61½	74½	25						
Sandy Lake Rapids to Moose Rapids, 14½ miles	30½								
Moose Rapids	18½	35							
Moose Rapids to Island Rapids, 15½ miles	13½								
Island Rapids	22	51	180	40	42	99			
Island Rapids to Rice River Portage, 7½ miles							1	16	8
Rice River Portage				200	24				
Aitkin to Tow Head Rapids, 25 miles	104	26½							
Tow Head Rapids	81	37	65		4½	108			
Tow Head Rapids to end of work, 10 miles	104	15	130	28	20	108			
Total	957	554	986	423	168	696½	3		

After the close of the work the camp equipage, tools, etc., were hauled to Aitkin and stored there. Complete inventories of the property were taken, which are herewith submitted.

Mr. George Snetsinger, overseer and foreman, in immediate charge of the crew, is entitled to credit for zealous and faithful discharge of his duty.

Sketches have been prepared showing the work of improvement done at the points of the most importance on the section of river worked over, which are herewith submitted—eleven in all.

As a result of the work it is believed that the available channel has been increased in depth at least one foot throughout the length of river worked over.

Very respectfully, your obedient servant,

R. DAVENPORT,
Assistant Engineer.

Maj. W. A. JONES,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Comparative statement of steamboat business on the Mississippi River between Aitkin and Grand Rapids, 1880-1890, inclusive.

Year.	Steam-boats.	Freight carried.	Passengers carried.	Total tonnage.	Year.	Steam-boats.	Freight carried.	Passengers carried.	Total tonnage.
		<i>Pounds.</i>		<i>Tons.</i>			<i>Pounds.</i>		<i>Tons.</i>
1880*	1	7,874,250	1,000	-----	1886	3	3,000,000	3,500	-----
1881	1	2,200,000	1,540	-----	1887	3	3,710,400	2,884	-----
1882	2	3,026,000	1,764	-----	1888	3	5,321,443	2,860	2,890
1883	2	2,800,000	1,100	-----	1889	2	7,000,000	5,250	3,925
1884	2	16,000,000	1,346	-----	1890	1	3,212,550	1,253	1,606
1885	2	5,000,000	2,400	-----					

* Amount of commerce and navigation when work of improvement began.

Amount of commerce and navigation, 1890, approximate.

Comparative statement of loose logs run on the Mississippi River above the Falls of St. Anthony.

Year.	Loose logs run.	Year.	Loose logs run.
1880	226,000,000	1886	282,600,000
1881	238,000,000	1887	*205,000,000
1882	285,000,000	1888	*265,000,000
1883	420,000,000	1889	288,000,000
1884	367,000,000	1890	325,669,280
1885	317,993,000		

* Approximate.

B B 2.

RESERVOIRS AT HEAD WATERS OF MISSISSIPPI RIVER.

The reservoir project is the outcome of surveys and examinations in 1869, 1874, 1878, and 1879, the results of which are published in appendices to various Annual Reports of the Chief of Engineers. The résumé of the subject is given in the report of the Board of Engineers, printed in Appendix A A to the Annual Report of the Chief of Engineers for 1887.

From the results of the surveys and examinations just noted and further examinations in 1880, the first cost of constructing 41 reservoir dams in Minnesota and Wisconsin was placed at \$1,809,083, exclusive of that of land damages, which could not be given in advance. (See page 1871, Appendix W to Report of the Chief of Engineers for 1881.)

The project for this improvement was inaugurated in 1880 by an appropriation for the construction of a reservoir dam at Lake Winibigoshish, made by act of Congress approved June 14 that year. For the reasons given in the Annual Report for 1886 the work of construction commenced and has been continued in Minnesota.

The project has for its object the construction and maintenance of reservoirs at the head waters of the Mississippi River, in the State of Minnesota, for the purpose of collecting the surplus water, principally from the precipitation of winter, spring, and early summer, to be systematically released so as to benefit navigation upon the Mississippi River below the dams and as far down as Lake Pepin. Reduction of heights

of floods in localities immediately below the dams expected to obtain to some extent, but control of extended floods or freshets not expected.

There are 4 completed reservoirs, viz:

At Lake Winibigoshish, completed in 1883-'84; capacity 45,800,000,000 cubic feet.

At Leech Lake, completed in 1884; capacity 30,000,000,000 cubic feet.

At Pokegama Falls, completed in 1884, lift of dam increased in 1889; capacity 4,700,000,000 cubic feet.

At Pine River, completed in 1886; capacity 7,500,000,000 cubic feet.

Congress, by act approved August 5, 1886, appropriated as follows:

For continuing operations upon the reservoirs at the head waters of the Mississippi River, thirty-seven thousand five hundred dollars: *Provided*, That, in the opinion of the Chief of Engineers, the expenditure of this appropriation and the ultimate completion of this part of the reservoir system will adequately improve navigation.

The subject was referred to the Board of Engineers mentioned above. The Board reported "they (the reservoirs) now 'adequately improve navigation' in the sense that they rendered a fair return for their cost." The Board also recommended further work and extension of the system at the headquarters of the Mississippi River, viz:

- (1) Raising the Pokegama Dam 2 feet.
- (2) Building a dam in the Sandy Lake district, if more elaborate surveys there confirm present indications.
- (3) Legislation to provide rules and regulations to govern the operations of the reservoirs.
- (4) Gaugings to be made at or near St. Paul during the annual operation of reservoirs.

The first and third recommendations of the Board have been carried into effect, and the fourth partially so. Legislation on these subjects was contained in the river and harbor act of August 11, 1888, as follows:

For continuing operations upon the reservoirs at the head waters of the Mississippi River, \$12,000 to be expended in accordance with the recommendation of the Board of Engineers in their report to the Chief of Engineers, dated May twenty-fourth, eighteen hundred and eighty-seven. And it shall be the duty of the Secretary of War to prescribe such rules and regulations in respect to the use and administration of said reservoirs as in his judgment the public interest and necessity may require, which rules and regulations shall be posted in some conspicuous place or places for the information of the public. And any person knowingly and willfully violating such rules and regulations shall be liable to a fine not exceeding \$500 or imprisonment not exceeding six months, the same to be enforced by prosecution in any district court of the United States within whose territorial jurisdiction such offense may have been committed. And the Secretary of War shall cause such gaugings to be made at or near St. Paul, during the annual operation of said reservoirs, as shall determine accurately the discharge at that point, the cost of same to be paid out of the annual appropriation for gauging the waters of the Mississippi River and its tributaries.

For gauging the waters of the Lower Mississippi and its tributaries, * * * nine thousand six hundred dollars.

SEC. 6. That for the purpose of securing the uninterrupted gauging of the waters of the Lower Mississippi River and its tributaries, as provided for in joint resolution of the twenty-first of February, eighteen hundred and seventy-one, upon the application of the Chief of Engineers, the Secretary of War is hereby authorized to draw his warrant or requisition from time to time upon the Secretary of the Treasury for such sums as may be necessary to do such work, not to exceed in the aggregate for each year the amount appropriated in this act for such purpose: *Provided, however*, That an itemized statement of such expenses shall accompany the Annual Report of the Chief of Engineers.

The lift of the Pokegama Falls Dam was raised 2 feet in 1889. Rules and regulations to control the use and administration of the reservoirs were formulated and approved by the Secretary of War, February 21,

1889. Gaugings of the Mississippi River at St. Paul have been made, to a limited extent, during the past two fiscal years; they form the subject of a separate report.

The final survey of the proposed Sandy Lake Reservoir was made in the fall of 1888.

Total expended upon this work, including examinations at proposed dam sites, hydrological observations, land damages, amounts set aside as awards to Indians, and care and maintenance of the works, to the close of the fiscal year ending June 30, 1890, \$623,986.63.

Amount expended during the fiscal year ending June 30, 1891, including outstanding liabilities, \$11,526.74.

Field operations during the past year were mostly confined to care and protection of dams and engineer property and recording hydrological and meteorological data. A sled road was constructed between Leech and Lake Winibigoshish dams, and the Lake Winibigoshish log sluice was repaired.

In the office, a design for Sandy Lake Dam was prepared and submitted to the Chief of Engineers, May 5; estimated cost, \$50,229.14. It was approved May 18, 1891. During the months of May and June the business of assembling the men and material for constructing the Sandy Lake Dam has proceeded, and the party is now on the ground. It was not considered advisable to attempt further operations while the river was occupied with so many log-drives.

It had been observed that during low stages in the Winibigoshish and Leech Lake reservoirs, it was only possible to make the dams discharge a very small quantity of water. In other words, their efficiency was practically at an end long before the water was drawn off. I found that at the former the old cofferdam had not all been removed above the sluices, and that the channel way from the lake was obstructed with grass. These removed only slightly remedied the matter, and the difficulty at both dams was found to be practically the same. Owing to the low slope and tortuous channels of the streams below the dams, it requires considerable head at each, *below the dam*, to create a velocity sufficient to overcome the excessive bed and bank friction arising from the local conditions. This head requires the water immediately below the dams to stand nearly on a level with that immediately above during low stages, and hence but small quantities of water could escape. About 1 foot of the holding capacity thus becomes useless in producing navigation discharges.

At Leech Lake the level above the dam can be considerably increased by dredging the river channel considerably above so as to admit something like the lake level to reach the dam. It is estimated that the sum of \$6,000 will accomplish this. At Winibigoshish this condition practically exists, so I had to look below for relief. Here the Mississippi winds in the most tortuous manner southward parallel to Ball Club Lake and has some slight rapids on the route; from the foot of Ball Club the Mississippi waters back up into that lake, making a difference of level of 10 feet between the head of the lake and the waters of Little Winibigoshish one-half mile distant. Obviously, if we lead the water across this neck it will take the waters away from the foot of the dam very rapidly, and enable us to drain the reservoir very rapidly in its lower stages. This can be done at a cost of \$5,000, and the expenditure is recommended.

The sum of \$80,000, appropriated September 19, 1890, is considered sufficient to complete the Sandy Lake Dam and pay all necessary land damages, and this will complete the reservoir system in Minnesota.

Therefore no further appropriation for construction purposes will be necessary. The sum asked for is intended to improve the low-stage operations of the two upper reservoirs and for ordinary repairs and maintenance. It must not be overlooked, however, that the time is soon to come when the decay of the woodwork in all of these dam structures will call for extensive repairs, and the demands may come very suddenly.

The project for Sandy Lake Dam has not looked to a structure with a navigable pass through it. A great deal of just complaint has been made that this will deprive navigation interests of a valuable field of operations in the waters above the dam. This demand can be met at a small cost and I therefore recommend that the sum of \$30,000 be provided for this purpose.

It is proposed during the coming year to complete the Sandy Lake Reservoir and to operate and maintain the completed system.

Condemnation proceedings to acquire title to lands between Pokegama Falls and Blackberry Brook that are liable to be overflowed by the operation of the reservoirs were commenced last year, but afterwards discontinued, as it was deemed more economical to obtain title, or the right to overflow, through private purchase. It is expected to accomplish this during the coming year as well as to obtain the right to overflow the private lands to be affected by the Sandy Lake Dam. A list of the latter lands was sent to the Chief of Engineers February 19, last, with recommendation that condemnation proceedings be commenced.

The beneficial effects resulting in previous years from the operation of the completed reservoirs have been maintained.

The Board of Engineers, in their report heretofore referred to, express this opinion:

As far down as the mouth of the first considerable tributary, the St. Croix, it is therefore not unreasonable to suppose that navigation may be benefited nearly in proportion to the effect upon the St. Paul gauge, *i. e.*, from 1 foot to 18 inches at low-water stages.

My predecessor, in his annual reports for the years 1887, 1888, and 1889, has stated:

From such observations as means admitted of in 1885 and 1886, and stated in my reports of December 18, 1885, and November 5, 1886, both of which are here respectfully referred to, it appeared that when the river stood at 2 feet on the U. S. Signal Service gauge at St. Paul, the effect of every 100 cubic feet per second of water added to the river and steadily maintained was equivalent to increasing the depth one-tenth of a foot. As the river rises the depth effect of each 100 cubic feet of water decreases somewhat. It appears, however, from examinations in 1885 and 1886, that the effect of the liberated water from the four reservoirs was the addition of 1 foot and upwards to the depth at St. Paul, during the dry periods of those years, the additional depth being due to elevation of water surface as well as to additional scour. (See Appendix AA, Annual Report, 1887.)

The benefit of the reservoir volume extended over some 425 [390] miles of river below Grand Rapids, the rapids being 388 [353] miles, by river, above St. Paul. Of the 425 [390] miles 200 [165] are navigated by steamers.

The increase in channel depth at St. Paul due to release of the stored-up water undoubtedly averaged for the 86 days 1 foot to 1½ feet. (See Appendix Z, Annual Report, 1888.)

The increase in channel depth at St. Paul due to the reservoir water undoubtedly averaged 1 foot during the low water season of 1888. (See Appendix BB, Annual Report, 1889.)

The effect of the reservoirs on the navigable depth of water in the channel of the Mississippi River above the Falls of St. Anthony is not as conclusively shown as it could be. A series of hydrological and meteorological observations on the Mississippi and the principal tributaries above St. Paul, extending over a period of several years, would furnish information not only of great practical value in the operation of the reservoirs, but would also be of scientific value in connection with

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the loss of river water by evaporation and filtration, and in the progression (and even dispersion) of a flood wave. A commencement in this direction has been made by the provision for gaugings at or near St. Paul, but the money available for the purpose is inadequate for thorough work, and is only applicable near St. Paul. It is estimated that the sum of \$15,000 per annum can be profitably expended in hydrological and meteorological investigations during a period of 4 years.

The sum of \$75,000 can be profitably expended during the fiscal year ending June 30, 1893, as follows:

Navigable pass in Sandy Lake Dam.....	\$30,000
Maintenance and ordinary repairs.....	19,000
Excavation at the two upper dams.....	11,000
Hydrological and meteorological investigations.....	15,000
Total	75,000

For commerce benefited by the reservoirs, reference must be made to the commercial statistics of the Mississippi River.

For valuable assistance in work upon, and management of, the reservoirs, I am greatly indebted to Mr. Archibald Johnson, assistant engineer.

ABSTRACT OF APPROPRIATIONS.

By act approved June 14, 1880.....	\$75,000
By act approved March 3, 1881.....	150,000
By act passed August 2, 1882.....	300,000
By act approved July 3, 1884.....	67,000
By act approved August 5, 1886.....	37,500
By act of August 11, 1888.....	12,000
By act approved September 19, 1890.....	80,000
Total	714,500
Allotment per letter from Office Chief of Engineers—	
November 9, 1881.....	1,572. 15
January 20, 1882.....	176. 00
January 18, 1888.....	643. 85
May 11, 1888.....	8. 60
Awards to Indians for damages in connection with the building of Leech Lake and Lake Winnibigoshish dams, letter from office Chief of Engineers, August 7, 1885.....	15,996. 90
Allotted and expended by officer in charge for meteorological observations, borings, examinations, etc., at proposed dam sites, letter from office of Chief of Engineers, May 27, 1881.....	7,500. 00
Expended by officer in charge in connection with the building and operating of four reservoir dams to June 30, 1891, including outstanding liabilities.....	609,615. 87
Total allotted and expended to June 30, 1891, including outstanding liabilities	635,513. 37
Estimated cost of the system (omitting that of land, etc., damages)...	1,809,083. 50
Amounts appropriated.....	714,500. 00
Remaining to be appropriated.....	1,094,583. 50

Money statement.

July 1, 1890, balance unexpended.....	\$11,799. 34
Amount appropriated by act approved September 19, 1890.....	80,000. 00
	91,799. 34
June 30, 1891, amount expended during fiscal year.....	11,772. 2
July 1, 1891, balance unexpended.....	80,027. 1
July 1, 1891, outstanding liabilities.....	1,040. 42
July 1, 1891, balance available.....	78,986. 6

Amount (estimated) required for completion of existing project.....	\$1, 094, 583. 50
Amount that can be profitably expended in fiscal year ending June 30, 1893	75, 000. 00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

B B 3.

IMPROVEMENT OF CHIPPEWA RIVER. INCLUDING YELLOW BANKS, WISCONSIN.

The plan for improvement of the Chippewa River consists in revetment of caving bends and construction of dams and jetties from Eau Claire to the confluence of the stream with the Mississippi River, a distance of 57 miles, to confine the low-water volume to a channel of nearly uniform width and depth. The general plan for improvement was adopted in 1877, and the work has been carried on in accordance with it, varying, however, more or less, as to location and extent of dams, jetties, etc.

The object of protection of the Yellow Banks is to prevent erosion of the high sand bluffs or banks bordering the Chippewa River at a number of points below Eau Claire, and to thereby relieve the channels of that river and of the Mississippi below the junction of the two streams from the masses of sand contributed by those banks. The plan for protection consists in a revetment of piling and fascines, the latter to be crowned with rock.

The examination of the river upon which the plan and estimate were based was made in 1874. The report, dated January 30, 1875, of this examination, is printed in Part I, Appendix to the Annual Report of the Chief of Engineers, pages 375-380. In that report the estimate of cost of improvement, including protecting the Yellow Banks, was \$139,892.50.

The first appropriation for improving the Chippewa River was made in 1876, and the first for protection of the Yellow Banks was made in 1882. These were regarded as separate and distinct works until the act of Congress of August 11, 1888, appropriated for the improvement of the Chippewa River, including Yellow Banks in said river, Wisconsin, continuing improvement, \$10,000.

The estimated cost, including all expenditures since 1876, for channel improvement of the river, as revised by my predecessor in 1888 (see pages 1543, 1544, Annual Report for 1888), was placed at \$176,487.72. The cost of protecting the Yellow Banks, as revised by the same officer in 1883 (see page 1443, Annual Report for 1883), was estimated at \$96,000, making the total cost for channel improvement and the protection of the Yellow Banks \$272,487.72.

There has been appropriated for the Chippewa River improvement and the Yellow Banks the sum of \$166,750, leaving a balance of \$105,737.72 remaining to be appropriated in order to complete the existing projects in accordance with the estimates.

Before the improvement commenced the depth on the bars at low water seldom exceeded 18 inches, and the crossing at the mouth of the river was extremely difficult at that stage, owing to the volume of the river joining the Mississippi through a number of channels of insufficient depth.

Total expended from commencement of operations in 1877 to June 30, 1890, including outstanding liabilities, \$156,048.25.

In the Annual Report for 1889 (page 1796) my predecessor reported:

Wherever works have been constructed by the Government for the improvement of the river the navigation has been benefited, a low-water depth of 3 to 4 feet be-

ing maintained where before the works were undertaken the depth seldom exceeded 18 inches. The work for improvement has been principally confined to the extent of river between the mouth and Durand, 16½ miles, and to the vicinity of Eau Claire.

The jetties at the mouth of the river have been of incalculable benefit to raft and steamboat navigation in securing a stable channel of sufficient depth where before improvement commenced there was a broad bar, intersected by shallow, shifting channels, passable with great difficulty at times of low water by rafts and steamers.

The injurious effects upon the channel from the operation of private sluicing dams on the river and its tributaries has been noticed in precedings reports.

Since the branch of the Chicago, Milwaukee and St. Paul Railway has been built, in 1882, from Wabasha, on the Mississippi River, to Eau Claire, the branch being close to and generally parallel with the Chippewa, the freight and passenger traffic of the latter has declined. The rafting of manufactured lumber, laths, shingles, and pickets varies in different years, the rafts moving down the Chippewa and between the jetties into the Mississippi. In 1881 the lumber rafted was reported as 342,887,000 feet, B. M.; in 1885, 374,138,443 feet; in 1886, 207,205,672 feet; in 1887, 186,826,521 feet; and in 1888, 161,309,512 feet. The sawlogs, from 300,000,000 to 600,000,000 feet, B. M., which are annually run down the Chippewa, are made up into rafts at Beef and West Newton sloughs for points on the Mississippi River.

The reduction in the cost of running lumber from Eau Claire to the Mississippi River, due to the improvement of the river by the United States, can be arrived at by comparing the contract rates paid by the Daniel Shaw Lumber Company. In 1877, the year when the improvement was commenced, they paid 53½ cents per thousand feet, B. M.; in 1886 and 1887 they contracted for 37 cents.

The localities remaining to be improved have a least depth in the channel of about 2 feet.

The work during the past fiscal year has consisted only in the care of plant and investigation of alleged railroad obstructions. The money appropriated in the river and harbor act of September 19, 1890, did not become available until too late to enable work to be done advantageously last fall. Operations will be resumed in July or August.

Expended during the fiscal year, including outstanding liabilities, \$1,359.41.

The sum of \$60,000 can be profitably expended during the fiscal year ending June 30, 1893.

This work is in the collection district of Milwaukee, Wis. The duties on imports collected during the year ending December 31, 1890, amounted to \$328,360.08.

ABSTRACT OF APPROPRIATIONS.

By act approved—	
August 14, 1876	\$10, 000
June 8, 1878	10, 000
March 3, 1879	8, 000
June 14, 1880	10, 000
March 3, 1881	10, 000
By act passed August 2, 1882	65, 000
By act approved July 5, 1884	15, 000
By act approved August 5, 1886	18, 750
By act of August 11, 1888	10, 000
By act approved September 19, 1890	10, 000
Total	166, 750

Money statement.

July 1, 1890, balance unexpended	\$904. 35
Amount appropriated by act approved September 19, 1890	10, 000. 00
	<hr/> 10, 904. 35
June 30, 1891, amount expended during fiscal year	1, 468. 43
	<hr/> July 1, 1891, balance unexpended
July 1, 1891, outstanding liabilities	9, 435. 87
	<hr/> 93. 53
July 1, 1891, balance available	<hr/> 9, 342. 34

{ Amount (estimated) required for completion of existing project.....\$105,737.72
 Amount that can be profitably expended in fiscal year ending June 30, 1893 60,000.00
 Submitted in compliance with requirements of sections 2 of river and
 harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The following shows the commerce of the Chippewa River, Wisconsin, in 1877, being the year following the first appropriation (August 14, 1876), for work of improvement:

Lumber feet, B. M. . 160,000 000
 Laths and pickets number.. 30,000,000
 Shingles do .. 40,000,000

The number of steamboats plying on the Chippewa River in 1877, or the amount of business done by them, can not be stated exactly. It is said, however, that the business was about the same as in 1881 and 1882. The latter will be found in the comparative statement following.

But one steamboat plied regularly on the river during the season of 1890. This boat, the *Phil. Shekel* (108 tons burden and 2 feet draft), ran from the mouth to Dunnville, about halfway between the mouth and Eau Claire, to assist the Knapp, Stout & Co. rafts in floating down the river. Her passengers and freight were confined entirely to the company's rafting business.

Comparative statement of freight and passengers for 9 years.

Year.	Steam-boats.	Freight carried.	Passen-gers.	Year.	Steam-boats.	Freight carried.	Passen-gers.
		<i>Pounds.</i>				<i>Pounds.</i>	
1890.....	*1	.....	.....	1885.....	1	690,000	4,728
1889.....	*1	.....	.....	1884.....	2	1,500,000	5,500
1888.....	1	.....	.....	1883.....	3	3,184,000	4,000
1887.....	1	600,000	1,400	1882.....	3	2,640,000	10,490
1886.....	1	.....	4,700	1881.....	3	3,932,000	16,980

* One hundred and eight tons burden and 2 feet draft.

Comparative statement of lumber, laths, shingles, pickets, and logs for 9 years.

Year.	Lumber.	Laths.	Shingles.	Pickets.	Total ton-nage, exclu-sive of loose logs.	Beef Slough logs.
	<i>Feet. P. M.</i>	<i>Number.</i>	<i>Number.</i>	<i>Number.</i>	<i>Tons.</i>	<i>Feet B. M.</i>
1890.....	146,777,966	46,234,673	78,499,500	1,222,989	342,350	606,992,790
1889.....	158,938,294	50,487,355	112,053,075	2,244,786	329,156	400,518,720
1888.....	161,309,512	50,544,370	96,348,900	1,500,320	325,971	542,437,000
1887.....	184,826,521	64,725,580	130,516,200	3,023,235	.....	404,302,650
1886.....	207,205,072	77,729,630	158,645,750	1,934,340	.....	465,000,000
1885.....	374,138,443	95,992,900	195,890,220	75,000,000	.....	600,000,000
1884.....	298,344,561	88,905,520	160,133,000	1,840,278	.....	534,674,176
1883.....	269,094,203	82,643,500	129,754,000	1,497,948	.....	450,000,000
1882.....	375,000,000	66,000,000	150,000,000	2,200,000	.....	350,000,000
1881.....	342,887,000	64,787,600	121,437,000	1,880,900	.....	300,000,000

B B 4.

IMPROVEMENT OF ST. CROIX RIVER, WISCONSIN AND MINNESOTA.

The original project for the improvement of this river, adopted in 1878, was based upon the results of a survey made in 1874, when the St. Croix was at a high stage of water and but comparatively few bars, etc., to be seen, contemplated the removal of snags, bowlders, wrecks, leaning

trees, and sand bars between Taylor Falls and Prescott, and contraction of low-water channel between Taylor Falls and Stillwater into one of nearly uniform width by means of brush and stone jetties and dams of the same material, to close island chutes and secondary channel. Estimated cost, \$21,758.

The present project, adopted in 1880, and modified in 1882, and again in 1889 (see page 1801, Annual Report, 1889), by my predecessor, is based upon the results of a low-water survey made in 1879. The estimated cost has been placed at \$108,700.

In the Annual Report for 1889 he reported:

The first appropriation for the improvement of the St. Croix was \$10,000, made by act of Congress approved June 18, 1878.

At that date the channel, above Stillwater especially, was encumbered by sunken cribs, wrecks, snags, and old boom piers, and the bends by leaning trees. The low-water channel had in many places but 2 feet of depth, and steamers and barges made their way as best they could amongst the obstructions. At times it was impossible for them to get over the shoal places. Under this appropriation some of the worst obstructions were removed between Taylor Falls and Stillwater.

Another appropriation of \$3,000, by act approved March 3, 1879, was expended in the same manner, and in addition the stream was thoroughly surveyed from Taylor Falls to Prescott, the results of which were reported January 26, 1880. (See pages 1661-1667, Appendix U, Annual Report of the Chief of Engineers, 1880.) Upon the results and map of this survey is based the present plan of improvement.

The work performed in 1878-'79 lessened the difficulties to navigation within the limits worked over.

Under the appropriation of \$10,000, by act approved June 14, 1880, work began under the present project, which consists in the construction of dams and jetties to confine the low-water volume to a practicable channel, and in removal of snags, bowlders, cribs, and other obstructions from the channels between Taylor Falls and Prescott.

* * * * *

The result of the work to date is a least depth upon the bars above Stillwater, where improvements have been made, of 3 feet at low water, and below Stillwater of 4 to 5 feet. Generally, it may be said of the work that at many points navigation has been rendered permanent where formerly it was uncertain, and that in other places it has been made practicable where before improvement it was impossible.

In the unimproved parts of the river above Stillwater there is a low-water depth in the channel of 2 feet; below Stillwater there is a good channel with a least depth of 4 feet.

Expended under present project to June 30, 1890, including outstanding liabilities, \$74,455.94.

Total expended under original and present projects to June 30, 1890, including outstanding liabilities, \$92,455.94.

Operations during past fiscal year were confined to dredging on the shallow bars. Field work commenced October 20 and continued until November 9. The advent of winter prevented further operations. During this period an area of 125,360 square feet on the bar above the Hudson Bridge was dredged and 11,507 cubic yards of material removed. The cost was 20 cents per cubic yard.

Work was resumed May 30, 1891, and continued during the month of June, during which time dredging was done on the bars above Hudson Bridge, below the bridge, and at the lower end of the boom at the head of Lake St. Croix.

The whole quantity of material removed during the fiscal year was 25,919 cubic yards. The cost was 20 cents per yard.

The total expenditure for the year was \$6,262, leaving a balance of \$1,782.06 which will be expended during the month of July, 1891, in dredging upon the bars at the head of Lake St. Croix, and at Hudson and in removing sunken sawlogs from the lake and river.

The condition of this river is now substantially as follows: From the head of Lake St. Croix to the Mississippi River there is a good channel

of 4 feet at extreme low water. From the head of Lake St. Croix to the head of navigation at Taylor Falls there is a minimum navigable depth of about 2 feet at extreme low-water stage. The principal commerce of this river is in logs and log products. The volume is surprising. The quantity of logs brought to market at Stillwater during the season of 1890 was 460,000,000 feet or 1,610,000 tons. They are a product of the soil conveyed to market by cheap water transportation. The cost of transportation is about 10 cents per ton per 100 miles, or $\frac{1}{10}$ cents per ton per mile. Obviously, without water transportation, the crop could not go to market, and the great lumber business of Minnesota and Wisconsin would not be in existence to-day. The output of logs during the same year on the Chippewa River was 606,992,790 feet and upon the Upper Mississippi 325,669,280 feet, making an aggregate tonnage on the three rivers of about 4,874,317 tons valued at \$14,000,000 from one product of the soil alone.

It is therefore quite evident that the American sawlog, navigating itself upon our water transportation lines, is an object worthy of consideration, and that some of our efforts at river improvement should be devoted to helping it along. Not, however, to the extent of allowing it to paralyze boat navigation. Measures should be taken to require a sufficient number of men to accompany the drives to prevent the logs from forming jams, which totally obstruct navigation.

It is proposed during the coming year to improve the reach of river between the head of navigation and deep water in Lake St. Croix. The sum that can be profitably expended thereon is \$26,200.

Total expended during the fiscal year ending June 30, 1891, including outstanding liabilities, \$6,262.

This work is in the collection district of Minnesota, of which St. Paul is the port of entry and St. Vincent a subport. Collections for year ending December 31, 1890, \$306,878.60. Value of domestic exports for same period, \$1,733,907.

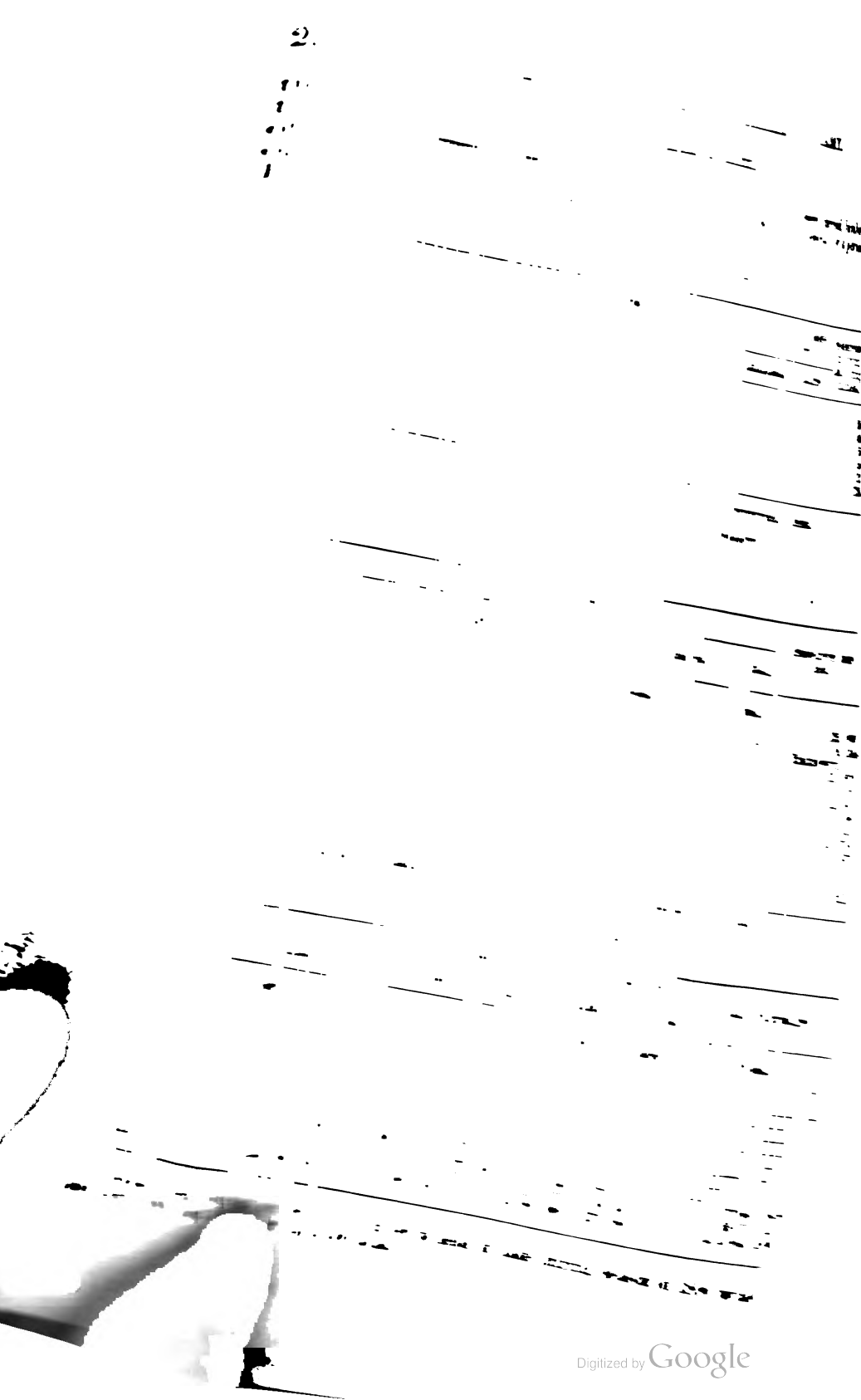
ABSTRACT OF APPROPRIATIONS.

By act approved—	
June 18, 1878	*\$10,000
March 3, 1879	*8,000
June 14, 1880	10,000
March 3, 1881	8,000
By act passed August 2, 1882	30,000
By act approved—	
July 5, 1884	9,000
August 5, 1886	7,500
By act of August 11, 1888	10,000
By act approved September 19, 1890	8,000
Total	100,500

Money statement.

July 1, 1890, balance unexpended	\$65.69
Amount appropriated by act approved September 19, 1890	8,000.00
	8,065.69
June 30, 1891, amount expended during fiscal year	3,268.70
July 1, 1891, balance unexpended	4,796.99
July 1, 1891, outstanding liabilities	3,014.93
July 1, 1891, balance available	1,782.06
{ Amount (estimated) required for completion of existing project	26,200.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	26,200.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867	

* Appropriated before adoption of present project.



B B 5.

IMPROVEMENT OF MINNESOTA RIVER, MINNESOTA.

An examination of this stream was made by Maj. G. K. Warren, Corps of Engineers, in 1866, under authorization of section 4 of the act of Congress approved June 23, 1866. Major Warren's first or preliminary report of this survey was rendered January 21, 1867, and printed as a part of Senate Ex. Doc. No. 58, Thirty-ninth Congress, second session.

The estimates of cost of improvement, based upon results of this examination and survey, are given in the Report of the Chief of Engineers for the year ending June 30, 1867. Two plans are considered, viz, one to improve the navigation of the river from the Yellow Medicine to the mouth of the Minnesota by means of locks and dams, so as to secure 4 feet of water, at a cost of \$775,500, and another to secure 2 to 3 feet of water by removal of snags and bowlders throughout this stretch of river, in addition to the construction of a lock and dam at Little Falls and the operation of a scraper and dredge boat at a cost of \$117,000.

The river and harbor act of Congress approved March 2, 1867, appropriated \$37,500 for removing snags and bowlders throughout the Minnesota River, thus sanctioning the second plan.

The river and harbor acts of Congress approved June 11, 1870, and March 3, 1871, each appropriated \$10,000 for continuing the improvement.

The second section of the river and harbor act of Congress approved June 10, 1872, provided for the survey of the Minnesota River above the mouth of Yellow Medicine, which survey was made during the same year, the report pertaining to which is printed in the Report of the Chief of Engineers for the fiscal year ending June 30, 1873. The removal of obstructions, principally bowlders, was recommended.

The same act (approved June 10, 1872,) appropriated \$10,000 for the improvement of the stream, which sum was expended in the removal of bowlders, overhanging trees, etc.

By act approved March 3, 1873, there was appropriated—

For the improvement of the Minnesota River, Minnesota, \$10,000; provided, that one-half of said sum shall be expended between the mouth of the Yellow Medicine and Minnesota Falls, on said river.

This appropriation was applied to the removal of rocky ledges, bowlders, snags, and overhanging trees. The total of appropriations to March 3, 1873, inclusive, was \$77,500.

By act of Congress approved June 23, 1874, an appropriation of \$10,000 was made "for the survey or improvement of the Minnesota River." A survey was made from the mouth of the river to South Bend, a distance of 116.4 miles, to determine the practicability of improving the navigation by means of canals, locks, and dams. The results of this survey proved the possibility of lock and dam navigation for the distance passed over, the estimated cost of improvement, as stated in the report of the survey printed in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1875, being for five locks and dams and removal of snags, etc., \$733,868.63, the cost of removing snags, etc., being therein placed at \$34,585.10, including contingencies. Following this report Congress made three appropriations of \$10,000 each, by acts approved March 3, 1875, August 14, 1876, and June 18, 1878, which sums were applied to clearing the river of obstructions below South Bend.

The appropriations up to and including that of June 18, 1878, were applied in removing snags, bowlders, etc., on the upper part of the river between Minnesota Falls and a point 30 miles below Henderson (16.7 miles above Shakopee). The rapidly caving banks on this stretch of the river add snags and leaning trees to the channel yearly, so that channels which were cleared 12 years ago are incumbered with them to-day.

- No money has been spent on the lower part of the river, which presents a marked contrast to the upper section.

Below Shakopee the river is, in the main, very deep, almost free from snags and caving banks, and would offer exceptional advantages to the navigation thereof were communication between it and the Mississippi River rendered possible by the improvement of the bar at the mouth of the river, and an increased depth provided over Credit River Bar (or Peterson's Bar, as it is sometimes called), just below Shakopee.

It is claimed by those interested in the Minnesota Valley that, were the improvements extended by the construction of locks and dams, steamboats and barges would navigate the river and carry much of the freight that now depends upon rail for transportation.

The river and harbor act of Congress approved August 5, 1886, authorized a survey of the Minnesota River with a view to its improvement by locks and dams. The survey, extending from the mouth of the river to Mankato, was made by my predecessor during the season of 1887, and a report thereon, with maps, rendered January 16, 1888. This report was printed in House Ex. Doc. No. 158, Fiftieth Congress, first session.

By the river and harbor act of August 11, 1888, Congress appropriated for—

Improving Minnesota River, Minnesota, including protecting and holding the banks opposite the borough of Belle Plaine, so as to prevent the river from cutting through the narrow neck of land at that point and thereby changing its channel and course, \$10,000.

This is the first appropriation made since 1878 for the improvement of the Minnesota River.

Concerning the expenditure of this appropriation my predecessor reported (see page 1804, Annual Report, 1889):

An examination of the river at Belle Plaine, and also from Carver to the mouth of the stream, was made in September, 1888, with a view to obtaining data upon which to base a project for the advantageous expenditure of the sum appropriated by the act of August 11, 1888.

The examination showed that there had not been any marked erosion of the bend at Belle Plaine for several years past; but that to thoroughly protect it against such erosion as might occur from floods or from changes in the channels of the river above the bend would undoubtedly cost more than the entire sum appropriated for the river. It also showed that there had not been any steamboat navigation of the river at that point (an occasional trip by a steamboat at high water excepted) for a number of years.

The cost of an adequate open-channel improvement of the river from its mouth to Carver, such an improvement as might last for a number of years, was found to be not less than \$52,000.

The appropriation being inadequate for thorough work at either Belle Plaine or the extent of river from its mouth to Carver, and still less adequate for the performance of work if divided between them, it was recommended that the submitting a project for expenditure of the appropriation be delayed until the further wishes of Congress might be known, or until some definite information as to prospective navigation might be obtained upon which to base a project for the best utilization of the appropriation.

Since the submission of the foregoing report it has been represented by reliable parties that a large amount of brick, hay, lime, and wood would be carried by steamboats and barges from points near Shakopee

to St. Paul were navigation made certain throughout the season, and that there is an excellent opportunity for a general packet business between the Mississippi River and points on the Lower Minnesota River, which would result in a material reduction of freight rates between these points.

It is recommended that the sum of \$10,000, appropriated in the act of August 11, 1888, be reappropriated, omitting the requirement for operations at Belle Plaine. This will enable me to open the river from the Mississippi to Shakopee, a distance of 25.9 miles. That is to say, with the sum of \$10,000 already appropriated, a water transportation line 25.9 miles in length can be opened at a cost of \$386 per mile. It is estimated that a business of 25,000 tons per annum is now ready to avail itself of the line.

In this connection I report from my predecessor, Major Allen (see Annual Report, Chief of Engineers, 1888, page 1574):

From consideration of all the facts that I have been able to collect I am of the opinion that the Minnesota River, from its mouth to Mankato, is worthy of improvement.

Total expended under the project following the survey of 1874 to June 30, 1890, including outstanding liabilities, \$30,042.

Total expended under all projects, including the survey, to June 30, 1890, inclusive, \$117,532.

There are no operations to report for the past year.

Amount expended during the fiscal year ending June 30, 1891, \$0.79.

Should Congress order an open-channel improvement below Carver the sum of \$25,000, in addition to that appropriated in 1888, could be expended during the fiscal year ending June 30, 1893.

This work is in the collection district of Minnesota, of which St. Paul is the port of entry and St. Vincent a support. Collections for year ending December 31, 1890, \$305,878.60; value of domestic exports for same period, \$1,733,907.

ABSTRACT OF APPROPRIATIONS.

By act approved—

March 3, 1867	\$37,500
July 11, 1870	10,000
March 3, 1871	10,000
June 10, 1872	10,000
March 3, 1873	10,000
June 23, 1874	*10,000
March 3, 1875	10,000
August 14, 1876	10,000
June 18, 1878	10,000
By act of August 11, 1888	10,000

Total 127,500

Money statement.

July 1, 1890, balance unexpended	\$9,967.00
July 1, 1891, balance unexpended	9,967.00
July 1, 1891, outstanding liabilities	9.79
July 1, 1891, balance available	9,957.21

{ Amount (estimated) required for completion of existing project	693,868.63
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	25,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

* Used in making survey of river.

COMMERCIAL STATISTICS.

Year.	Steamboats plying on lower part of river.			Freight carried.					
	No.	Tonnage.	Draft.	Wheat.	Hay.	Wood.	Brick.	Miscellaneous.	Total.
		Tons.	Inches.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
1888	1	{ 153	{ 18 }						3,350
1889	2	{ 180	{ 20 }						4,900
		{ 117	{ 18 }						
1890	3	{ 153	{ 30 }	62	800	840	1,080	842½	3,632½
		{ 180	{ 20 }						

B B 6.

IMPROVEMENT OF RED RIVER OF THE NORTH, MINNESOTA AND NORTH DAKOTA.

The present, which is also the original project for the improvement of this river from Breckenridge to the northern boundary line, adopted in 1877 and amended as to estimate of cost in 1883, consists in the removal of snags, leaning trees, and boulders, and in dredging channels through the bars.

The estimated cost of this improvement, omitting the item of improvement of Goose Rapids, as based upon the reports of 1874, 1875, and 1877 (see pages 730-732, Report of Chief of Engineers, 1878), was \$145,310.18, which estimate as revised, and for the reasons stated in Appendix X 8 of the Annual Report of 1883, was increased to \$179,310.18.

The river and harbor act of Congress, approved August 5, 1886, making the money theretofore appropriated for locks and dams at Goose Rapids available for dredging, removal of snags and boulders, and construction of wing dams, necessarily included in that mode of improving Goose Rapids, which were originally intended to be improved by means of locks. For this reason, as well as for others given in the annual report for 1887, a new estimate of cost of completing the work became necessary. The cost was placed at \$79,598.37. (See Appendix A A to the Annual Report of the Chief of Engineers for 1887, pages 1714, 1715.)

Previous to 1879, when the first bar was dredged through, the ruling depth at ordinary low water between Moorhead and Goose Rapids has been stated to have been but 1½ feet, and below Grand Forks but 2 feet.

A 3-foot channel at ordinary low water, averaging 60 feet in width, from Moorhead to a point 80 miles north, and a 4-foot channel at same stage averaging 70 feet in width, from Grand Forks to a point 62 miles north, by river, have been made by dredging through the bars.

The river is subject to land slides. These slides can never be anticipated, form obstructions when they occur, and have to be removed in whole or in part, thereby increasing the amount of cost of the improvement.

The removal of snags and trees between Moorhead and Abercrombie improved that portion of the stream for navigation during high and medium stages of water.

Expended upon the improvement from commencement of work in 1877 to June 30, 1890, including outstanding liabilities, \$187,042.79.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1891.

The low water of the spring and early summer of 1890 having continued for the remainder of the season, operations during the summer and fall were confined to completing the repairs to the dredging fleets that were begun earlier in the season. In addition to the repairs to the boats, a large derrick was placed on the bow of the steamer *Ogama*, for use in removing snags and bowlders. The repairs and the derrick cost \$2,474.79.

The season of 1891 has opened with a favorable stage of water for dredging operations. The fleet being in prime condition for work, advantage was taken of the situation to commence work early. Dredge No. 2 was taken from the winter quarters at Grand Forks and commenced work at a point 13 miles north on May 5. Dredge No. 1 was towed to Pelican Bars, 92 miles north of Grand Forks, and commenced work May 13. Both dredges have since been kept at work excavating channels 60 feet in width and 4 feet deep at low water.

Table of dredging work performed during fiscal year ending June 30, 1891.

	Excavation.	Length of channel made.	New cuttings.	Old cuttings extended, etc.	Wing and training dams.	River worked over.
	<i>Cu. yds.</i>	<i>Lin. ft.</i>	<i>No.</i>	<i>No.</i>	<i>Lin. ft.</i>	<i>Miles.</i>
Dredge No. 1	22,660	3,175	2	—	3,675	1½
Dredge No. 2	21,875	5,135	10	7	5,850	30
Total	44,535	8,310	12	7	9,525	31½

The total work done upon this stream since the first appropriation for its improvement was made in 1876, and extending from Fort Abercrombie to a point 93 miles north of Grand Forks, a total river distance of 321 miles, is as follows:

Cubic yards of material dredged	583,178
Snags removed	618
Overhanging trees removed	8,705
Cubic yards of bowlders removed	382
Stumps removed	198
Piles removed	23
Drift-piles (collections of driftwood, trees, etc.)	8
Barge removed	1
Total linear feet of channel excavated	105,297
Total linear feet of wing and training dams constructed	146,140

On the portions of the river worked over by the dredges the average depth of the channel has been increased from 1½ to 2 feet.

Mr. Rufus Davenport, assistant engineer upon this improvement for the past nine seasons, has exhibited faithfulness and zeal in carrying out the work intrusted to him.

All the work for the improvement of this stream has been performed by hired labor.

Expended upon this improvement during the fiscal year ending June 30, 1891, including outstanding liabilities, \$11,889.79.

The sum of \$34,598.37 can be profitably expended during the fiscal year ending June 30, 1893, in dredging operations and in removal of obstructions generally between Breckenridge and the northern boundary line.

This work is in the collection district of Minnesota, of which St. Paul is the port of entry and St. Vincent a sub-port. Collections for year ending December 31, 1890, \$305,878.60. Value of domestic exports for same period, \$1,733,907.

2212 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

ABSTRACT OF APPROPRIATIONS.

By act approved—	
August 14, 1876	\$10,000.00
June 18, 1878	30,000.00
March 3, 1879	25,000.00
June 14, 1880	20,000.00
March 3, 1881	18,000.00
By act passed—	
August 2, 1882	10,000.00
By act approved—	
July 5, 1884	10,000.00
August 5, 1886	46,947.65
By act of August 11, 1888	20,000.00
By act approved September 19, 1890	25,000.00
Total	214,947.65

Money statement.

July 1, 1890, balance unexpended	\$4,770.48
Amount appropriated by act approved September 19, 1890	25,000.00
	<hr/>
June 30, 1891, amount expended during fiscal year	29,770.48
	10,611.65
	<hr/>
July 1, 1891, balance unexpended	19,158.83
July 1, 1891, outstanding liabilities	3,143.76
	<hr/>
July 1, 1891, balance available	16,015.07
	<hr/>
{ Amount (estimated) required for completion of existing project	34,598.37
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	34,598.37
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. R. DAVENPORT, ASSISTANT ENGINEER.

GRAND FORKS, N. DAK., June 30, 1891.

MAJOR: The following report of operations in the improvement of the Red River of the North during the fiscal year ending June 30, 1891, is respectfully submitted.

Owing to the fact that the water remained too low to operate the dredges to advantage, the work during the last half of the season of 1890 was confined entirely to the continuation of the repairs on the dredging fleet.

The work on the hull of Dredge No. 1, *Unzer Fritz*, was completed, and after the launching the superstructure was thoroughly repaired and painted, a new boom built, and the machinery, as far as possible, prepared for the next season's work.

Steamboat No. 1, *General Poe*, was removed from the water and the hull repaired, calked, and painted. A new canvas roof, sanded and painted, was put on, and the superstructure painted throughout.

Quarter boat No. 2 was hauled out, the hull repaired and calked, and superstructure painted.

Quarter boat No. 1 was repaired and painted.

The work on Steamboat No. 2, *Ogama*, was continued to completion. A new canvas roof, sanded and painted, was put on, and a large derrick to be operated by the steam capstan for the removal of snags and boulders from the channel was constructed and placed in position on the forecabin. Some minor repairs were also made on the hull and machinery.

Some additional work was also done on the machinery of Dredge No. 2, *Otter Tail*, so as to have it as far advanced as possible for the resumption of dredging.

Such general repairs as were necessary on the remainder of the boats—derrick boat, barges, slide scows, skiffs, etc.—14 in all, were made and they were all painted.

The dredges and steamboats were lettered *U. S. Engineers*, with their several distinctive names.

The cost of the work was as follows:

Dredge No. 1	\$753. 76
Dredge No. 2	150. 66
Steamboat No. 1	394. 91
Steamboat No. 2	401. 58
Quarter boat No. 1	80. 68
Quarter boat No. 2	185. 29
General repairs on the remainder of the boats, 14 in all	507. 91

The total cost for repairs to the close of the season..... 2,474. 79

By these repairs all of the boats were put in as good shape as it was possible to make them; many of them have, however, been in service from 10 to 12 years, and, as a matter of course, repairs on boats of that age will only render them serviceable for a short time.

In the latter part of October the repair work was discontinued, and after a trip of inspection over the river to the north, on the steamer *Ogama*, from Grand Forks to the Pelican bars, the dredging fleet was put in shape for the winter and all work closed.

SEASON OF 1891 TO JUNE 30.

This year the preparatory work for the resumption of dredging was commenced in the latter part of April. Owing to the repairs of last season the preparatory work consisted of but little more than that of setting up the machinery of the dredges and steamboat.

Dredge No. 1 was started from Grand Forks on the 8th of May and towed to the Pelican Bars, 92 miles north, arriving at the upper bar on the 13th, when dredging was at once commenced.

The river in the vicinity of the Pelican bars is about 300 feet wide and the bars are very long. Since the work was started the dredge has excavated a 60-foot channel through the upper bar, 2,075 feet long, and is now at work on the second bar, which is about half completed.

Total excavation to date, 22,660 cubic yards. Length of channel-cutting, 3,175 linear feet. Length of wing and training dams formed with the excavated material, 3,675 linear feet. Length of river worked over, 1½ miles.

Dredge No. 2 was started from Grand Forks on the 4th of May and the work on the channel was commenced at a point about 13 miles north.

The work of Dredge No. 2 has so far been confined to the removal of a few small bars and to clearing and extending some of the old channel cuttings and repairing the wing and training dams.

This portion of the river has been improved in former years, but at a higher stage of water, so that some of the small bars that had before been passed over, it was now considered necessary to remove.

Total excavation to date, 21,875 cubic yards. Length of channel cuttings, 5,135 linear feet. Number of new channels cut, 10. Number of old cuttings widened and extended and the wing and training dams repaired, 7. Length of wing and training dams formed with the excavated material, 5,850 linear feet.

Length of river worked over, 30 miles.

Summary.

	Excavation.	Length of channel made.	New cuttings.	Old cuttings extended, etc.	Wing and training dams.	River worked over.
	<i>Cu. yds.</i>	<i>Lin. ft.</i>			<i>Linear feet.</i>	<i>Miles.</i>
Dredge No. 1	22,660	3,175	2	.....	3,675	1½
Dredge No. 2	21,875	5,135	10	..... 7	5,850	30
Total	44,535	8,310	12	7	9,525	31½

The new channels this year have all been made 60 feet wide, with a low-water depth of 4 feet.

Average cost of the dredging, 13 cents per cubic yard.

Cost of subsistence per ration, 38½ cents.

Steamboat No. 2, *Ogama*, operated in connection with the dredges, towing the fleet and keeping up the supply of fuel, subsistence, etc., has made 17 trips so far this

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season. Total miles run, 873. (The cost of maintaining and operating the steamboat is included in the cost of the work.)

Owing to low water during the last half of the boating season of 1890, all of the steamboats on the Red River were laid up. So far this year there has been a good navigable stage, averaging about 1½ feet on the Grand Forks gauge; a favorable stage, also, for the dredging operations.

The steamer *H. W. Alsop*, of the Red River Transportation Company, with a fleet of barges, has been operated day and night since the opening of navigation, bringing wheat from the north and south to Grand Forks. The steamer *Alsop* has, however, been the only boat run on the Red River this year.

Very respectfully, your obedient servant,

R. DAVENPORT,
Assistant Engineer.

Maj. W. A. JONES,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

There are two steamboat lines now on the Red River: At Fargo, N. Dak., the Grandin line; one steamer, the *Grandin*, 220 tons, with four barges, two of 300 tons, one of 250 tons, and one of 200 tons. At Grand Forks, the Red River Transportation Company, two steamboats, the *Pluck*, 36 tons, and the *H. W. Alsop*, 157 tons, with ten barges, four of 178 tons, one of 202 tons, one of 155 tons, one of 166 tons, and three of 72 tons.

Comparative statement of freight moved by steamboats and barges during the past 12 years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1890	1,710	1886	10,507	1882	31,652
1889	3,866	1885	23,043	1881	26,557
1888	12,140	1884	29,046	1880	21,651
1887	10,405	1883	25,314	1879	17,829

B B 7.

SURVEYS FOR RESERVOIRS AT THE SOURCES OF MISSISSIPPI, ST. CROIX, CHIPPEWA, AND WISCONSIN RIVERS.

Nothing was done under this head during the past fiscal year, no funds having been available for such work. For account in detail of these surveys reference is made to pages 1507 and 1508, Appendix Y, Part II, Annual Report of the Chief of Engineers, 1886.

Money statement.

{ Amount (estimated) required for completion of existing project..... \$50,000
 { Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

B B 8.

GAUGING MISSISSIPPI RIVER AT OR NEAR ST. PAUL, MINNESOTA.

The Board of Engineers, to whom was referred the project for the application of \$37,500, appropriated by the river and harbor act of August 5, 1886, for reservoirs at the headwaters of the Mississippi River,

recommended in their report, dated May 24, 1887, "that such gaugings be made at or near St. Paul during the annual operation of the reservoirs as shall determine accurately the discharge at that point at critical periods." (Page 1692, Annual Report Chief of Engineers, 1887.)

The river and harbor act of August 11, 1888, authorized the gaugings and provided for them as follows:

And the Secretary of War shall cause such gaugings to be made at or near St. Paul during the annual operation of said reservoirs as shall determine accurately the discharge at that point, the cost of the same to be paid out of the annual appropriation for gauging the waters of the Mississippi River and its tributaries.

Sec. 6. That for the purpose of securing the uninterrupted gauging of the waters of the Lower Mississippi River and its tributaries, as provided for in joint resolution of the 21st of February, 1871, upon the application of the Chief of Engineers, the Secretary of War is hereby authorized to draw his warrant or requisition from time to time upon the Secretary of the Treasury for such sums as may be necessary to do such work, not to exceed in the aggregate for each year the amount appropriated in this act for such purpose: *Provided, however,* That an itemized statement of said expenses shall accompany the Annual Report of the Chief of Engineers.

Gaugings were not made until the fall of 1889, although an allotment of \$900 for the fiscal year ending June 30, 1889, had been made. On account of the lateness in the season and the condition of the river it was not deemed advisable to expend any of the money that year.

The allotments of \$600 and \$900 made for the fiscal years 1889-'90, and 1890-'91, respectively, were applied to gauging the Mississippi River at St. Paul.

During the past year a total of 62 gaugings have been made, 57 of the Mississippi River at St. Paul and 5 of the Minnesota River at its mouth.

The following are the gaugings made during the fiscal year 1890-'91:

No.	Date.	Place.	Method.	Reading of St. Paul Signal Service Gauge.	Discharge in cubic feet per second.	Remarks.
1	Oct. 1	Mississippi River above Omaha Railway bridge, St. Paul.	Current meter ..	1.8	4,533.14	
2	Oct. 9	Mississippi River above Robert street bridge, St. Paul.	....do	1.81	4,100.14	
3	Oct. 11	....do .....	....do	1.70	3,939.36	
4	Oct. 15	....do .....	....do	2.26	4,789.26	
5	Oct. 16	....do .....	....do	2.30	4,788.93	
6	Oct. 16	Minnesota River at its mouth.	....do		442.50	
7	Oct. 23	Mississippi River above Robert street bridge, St. Paul.	....do	2.40	4,995.64	
8	Oct. 24	....do .....	....do	2.43	4,895.57	
9	Oct. 31	....do .....	....do	2.44	5,085.18	
10	Nov. 1	....do .....	....do	2.28	4,760.10	
11	Nov. 1	Minnesota River at its mouth.	....do		469.97	
12	Nov. 7	Mississippi River above Robert street bridge, St. Paul.	....do	2.11	4,647.99	
13	Nov. 8	Minnesota River at its mouth.	....do		302.43	
14	Nov. 26	Mississippi River above Robert street bridge, St. Paul.	....do	1.80	3,353.83	
15	Nov. 26	Minnesota River at its mouth.	....do		459.34	
16	Nov. 28	Mississippi River above Robert street bridge, St. Paul.do	1.35	3,451.68	

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No.	Date.	Place.	Method.	Reading of St. Paul Signal Service Gauge.	Discharge in cubic feet per second.	Remarks.
17	1890. Nov. 28	Minnesota River at its mouth.	Current meter		396.01	
18	1891. May 5	Mississippi River above Robert street bridge, St. Paul.	Electrical current meter.	4.75	10,160.00	Wind downstream.
19	May 6	do	do	4.64	10,357.63	Do.
20	May 7	do	do	4.52	9,329.56	Do.
21	May 8	do	do	4.46	9,153.88	Strong wind downstream.
22	May 9	do	do	4.32	8,633.54	Wind downstream.
23	May 11	do	do	4.06	8,359.85	Do.
24	May 12	do	do	3.92	7,919.28	Do.
25	May 13	do	do	3.75	7,502.04	Do.
26	May 14	do	do	3.78	7,519.57	Do.
27	May 15	do	do	3.71	7,424.08	Wind upstream.
28	May 16	do	do	3.74	7,502.52	Do.
29	May 18	do	do	3.42	6,934.57	Strong wind downstream.
30	May 19	do	do	3.29	6,591.44	Do.
31	May 20	do	do	3.07	6,191.61	Wind downstream.
32	May 21	do	do	3.14	6,432.89	Wind upstream.
33	May 22	do	do	3.05	6,311.36	Do.
34	May 23	Mississippi River at Dayton Bluff, St. Paul.	do	2.99	6,175.12	
35	May 24	do	do	2.89	6,100.76	
36	May 26	do	do	2.93	6,035.22	
37	May 27	do	do	2.80	5,919.99	
38	May 29	do	do	2.81	5,730.81	Wind upstream.
39	May 30	do	do	2.82	5,875.40	
40	June 4	Mississippi River above Robert street bridge, St. Paul.	do	2.84	6,072.79	
41	June 5	Mississippi River at Dayton Bluff, St. Paul.	do	2.77	5,853.64	Wind downstream.
42	June 6	do	do	2.77	5,729.17	
43	June 8	Mississippi River above Robert street bridge, St. Paul.	do	2.64	5,675.02	
44	June 9	do	do	2.72	5,700.42	
45	June 10	do	do	2.67	5,639.27	Strong wind downstream.
46	June 11	do	do	2.61	5,564.34	
47	June 12	do	do	2.51	5,214.55	
48	June 13	do	do	2.57	5,318.79	
49	June 15	do	do	2.56	5,407.31	
50	June 16	do	do	2.81	5,933.94	
51	June 17	do	do	2.82	6,007.86	
52	June 18	do	do	2.81	5,838.88	
53	June 19	do	do	2.82	6,003.20	
54	June 20	do	do	2.81	5,887.48	
55	June 22	do	do	2.61	5,422.93	
56	June 23	do	do	2.56	5,410.50	
57	June 24	do	do	2.72	5,068.10	
58	June 25	do	do	2.59	5,429.54	Rain.
59	June 26	do	do	2.39	5,250.62	Wind upstream.
60	June 27	do	do	2.60	5,400.10	Rain.
61	June 29	do	do	2.77	5,829.13	Strong wind downstream.
62	June 30	do	do	2.70	5,622.01	

The gaugings were made by observing the mid-depth velocities in sections 20 feet apart. Mean velocity was taken as 95 per cent. of mid-depth velocity.

A series of observations were taken in June to determine the ratio, $\frac{V_m}{V_{1/2}}$, for the gauging section at St. Paul, and was found to be 0.948.

The results of the gaugings are interesting and valuable so far as they go, but the money heretofore allotted and made available for gaugings has been inadequate to procure the information needed for a correct and scientific investigation of the effect of the reservoir water on the

Mississippi River. It is imperative that this effect shall be ascertained and established beyond question. The knowledge gained would be of use, not only in connection with the present reservoir system at the head waters of the Mississippi River, but also in determining the value of reservoirs as a means of improving rivers in general.

It is recommended that Congress be asked to fix the amount to be annually available for this specific work. An examination of the legislation affecting gauges indicates that Congress intended the sum to be \$4,600. Previous to the act of August 11, 1888, the annual expenditures of gauges and gauging of the Lower Mississippi River was limited by law to \$5,000. When, in 1888, it was provided for paying the expenses of "gaugings at and near St. Paul," etc., "out of the annual appropriation for gauging the Mississippi River and its tributaries," the limit was increased to \$9,600.

Amount expended during fiscal year ending June 30, 1891, including outstanding liabilities, \$900.

ABSTRACT OF ALLOTMENTS.

For fiscal year ending June 30, 1889	*\$900.00
For fiscal year ending June 30, 1890	600.00
For fiscal year ending June 30, 1891	900.00

Money statement.

Amount allotted for fiscal year ending June 30, 1891	\$900.00
Amount allotted for fiscal year ending June 30, 1892	900.00
	<hr/>
	1,800.00
June 30, 1891, amount expended during fiscal year	620.93
	<hr/>
July 1, 1891, balance unexpended	1,179.07
July 1, 1891, outstanding liabilities	279.07
	<hr/>
July 1, 1891, balance available	900.00
	<hr/>
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	4,600.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Itemized statement of expenditures during the fiscal year ending June 30, 1891.

Date.	To whom paid.	For what paid.	Amount.
1890.			
Oct. 28	C. H. Newbury	Pay roll, October, 1890	\$2.00
Oct. 28	A. E. Waldron	do	2.50
Nov. 5	D. W. Collier	do	32.91
	Louis Gibson	do	10.50
Nov. 6	Scribner-Libbey Co.	Sinkers, etc.	6.14
	A. O. Powell, assistant engineer	Traveling expenses	2.69
Nov. 13	Boeringer & Son	Tags	1.00
	Ames, Wright & Co.	Wire .....	.33
	Sundry persons	Part pay roll for November, 1890	6.61
Nov. 18	Henry E. Wedelstaedt & Co.	Level books	1.00
	Soren Denesen	Washing	4.05
Nov. 28	J. B. Rives	Services	2.50
	Robinson & Cary Co.	Shave, etc.	6.83
	George J. Grant	Lumber, etc.	2.80
	Brown, Tracy & Co.	Stationery	11.25
Dec. 9	Sundry persons	Part pay roll for November, 1890	11.38
	A. O. Powell, assistant engineer	Traveling expenses	4.86

* Not used.

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Itemized statement of expenditures during the fiscal year ending June 30, 1891—Continued.

Date.	To whom paid.	For what paid.	Amount.
1891.			
Apr. 23	Amea, Wright & Co.....	One dry battery.....	\$1.50
Apr. 24	James E. Auge.....	Use of skiff.....	2.00
May 11	Buff & Berger.....	Batteries, registers, etc.....	245.89
	Charles Godbout.....	Drayage.....	.50
May 20	Adam Decker & Co.....	Wire, etc.....	.25
June 1, 5	Sundry persons.....	Pay roll for May, 1891.....	185.00
June 5	do.....	Pay roll for April, 1891.....	13.50
June 18	Steamer <i>Henrietta</i>	Transportation.....	2.50
	Scribner-Libbey Co.....	Brass tubes, etc.....	36.85
	M. F. Kennedy & Bros.....	Oars, etc.....	2.00
June 22	George W. Allen.....	Traveling expenses.....	2.24
	Amea, Wright & Co.....	Battery.....	1.50
June 24	George W. Allen.....	Traveling expenses.....	1.10
June 26	Robinson & Cary Co.....	Wire rope, cord, etc.....	16.97
			620.93

Outstanding liabilities June 30, 1891.

To whom owing.	On account of—	Amount.
Sundry persons.....	Pay roll for June, 1890.....	\$273.50
D. Ramaley & Son.....	Envelopes.....	4.25
Henry E. Wedelstaedt & Co.....	Stationery.....	1.32
Expended during fiscal year ending June 30, 1891.....		279.07
Total.....		620.93
		900.00

B B 9.

PRELIMINARY EXAMINATION OF HARBOR AT HUDSON, WISCONSIN, WITH A VIEW TO PREVENT THE CITY BEING CUT OFF FROM THE NAVIGABLE CHANNEL OF THE ST. CROIX LAKE, AS A RESULT OF THE GOVERNMENT DIKE NOW CONSTRUCTED AT THAT POINT, AND WITH A VIEW TO THE FEASIBILITY OF CONDUCTING THE WATERS OF WILLOW RIVER PAST THE CITY OF HUDSON INTO THE NAVIGABLE CHANNEL OF THE LAKE.

[Printed in House Ex. Doc. No. 268, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS, UNITED STATES ARMY, Washington, D. C., February 18, 1891.

SIR: I have the honor to submit the accompanying copy of report dated February 10, 1891, from Maj. W. A. Jones, Corps of Engineers, giving results of preliminary examination of the harbor of Hudson, Wis., "with a view to prevent the city being cut off from the navigable channel of the St. Croix Lake, as a result of the Government dike now constructed at that point, and with a view to the feasibility of conducting the waters of Willow River past the city of Hudson into the navigable channel of the lake," made to comply with provisions of the river and harbor act approved September 19, 1890.

Major Jones reports that the city of Hudson has an excellent harbor and that the proposition to create a new channel for Willow River in order to improve a harbor that is good enough already is unreasonable and probably very expensive. Basing his opinion upon the facts set forth in his report, Col. O. M. Poe, Corps of Engineers, Division En-

gineer, Northwest Division, concurs with Major Jones that this harbor is not worthy of improvement in the manner designated by the act; and the views of these officers meet with my approval.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF MAJOR W. A. JONES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., February 10, 1891.

GENERAL: I have the honor to report the result of a preliminary examination of the "harbor at Hudson, Wis., with a view to prevent the city being cut off from the navigable channel of the St. Croix Lake, as a result of the Government dike now constructed at that point, and with a view to the feasibility of conducting the waters of Willow River past the city of Hudson into the navigable channel of the lake," as provided for in the river and harbor act of September 19, 1890.

The city of Hudson, Wis., lies upon the east bank of the lake portion of the St. Croix River. Willow River, a small stream, empties into the lake at the upper end of the city. At its mouth is a large bar with deep water above and below. The channel of the St. Croix River passes around the bar and along the west or Minnesota shore of the lake.

The bar may have been formed by sediment brought down Willow River as well as by other causes. At any rate the bar is of old formation, as shown by the fact that more or less bowlders are found on it which could not have been brought down by the action of Willow River.

Furthermore, Willow River has for many years past been improved for water-power purposes, and it is not likely that sediment in any great quantity is now carried through the mill pond to be deposited on the bar. The Chicago, St. Paul, Minneapolis and Omaha Railway Company took advantage of the bar to cross the lake.

I inclose herewith two maps* of the harbor of Hudson, one the result of a careful survey in 1879, prior to the construction of the Government dike referred to in the act, and the other from a survey made under my direction in January, 1891. These fully illustrate the situation, and from them it will be seen:

- (1) That the city of Hudson had an excellent harbor in 1879.
- (2) That she has to-day an excellent harbor.
- (3) That there has been no material change in the said harbor since 1879. The upper end of the Hudson Harbor has a soft bottom. The soundings made last month through the ice are probably more reliable than those made for the survey during open water in October, 1879. The soundings for the latter were made from a rowboat, on time and between located buoys. The sounder could not have had time to carefully feel of the bottom and may have measured mud as well as water. This explanation may account for the slight difference in depth exhibited by the surveys for the upper end or shoalest part of the harbor.
- (4) That the proposition to create a new channel for Willow River in

*Not reprinted.

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order to improve a harbor that is good enough already is unreasonable and probably very expensive.

Despite the fact of a good harbor at Hudson, there are no commercial statistics to report, since there has been no material commerce in recent times that I am aware of. These are the reasons which induce me to state that the harbor of Hudson is not, in my judgment, worthy of improvement.

Very respectfully, your obedient servant,

W. A. JONES,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer,
Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, February 13, 1891.

Respectfully forwarded.

Basing my opinion upon the facts set forth in this report, I concur with Major Jones that the harbor at Hudson, Wis., is not worthy of improvement by the General Government in the manner outlined in the terms of the act of September 19, 1890.

O. M. POE,
*Colonel, Corps of Engineers,
Division Engineer, Northwest Division.*

B B 10.

PRELIMINARY EXAMINATION OF RED RIVER OF THE NORTH, WITH A
VIEW OF IMPROVING THE NAVIGATION OF THE SAME BY THE CON-
STRUCTION OF A LOCK AND DAM AT GOOSE RAPIDS IN SAID RIVER.

[Printed in House Ex. Doc. No. 292, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 3, 1891.

SIR: I have the honor to submit the accompanying copy of report dated February 23, 1891, from Maj. W. A. Jones, Corps of Engineers, giving results of preliminary examination of "Red River of the North, with a view of improving the navigation of the same by the construction of a lock and dam at Goose Rapids in said river," made to comply with provisions of the river and harbor act approved September 19, 1890.

Major Jones reports that it is perfectly evident that a lock and dam would not only be an unnecessary obstruction in the navigation of the river, but that it would be an unnecessary expense, and therefore in his judgment the Red River of the North at Goose Rapids is not worthy of improvement by means of a lock and dam.

Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division, concurs in the opinion that this locality is not worthy of im-

provement as proposed by the act; and the views of these officers meet with my approval.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF MAJOR W. A. JONES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., February 23, 1891.

GENERAL: In compliance with the requirements of the act of Congress of September 19, 1890, I have the honor to report the result of a preliminary examination of—

Red River of the North, with a view of improving the navigation of the same by the construction of a lock and dam at Goose Rapids in said river.

This matter has been examined before, as follows:

This proposed improvement was first suggested by Major Farquhar in his report on an examination and survey of the river, dated March 4, 1874. In 1877 the same officer estimated the cost at \$219,287.99, and located the proposed improvement so as to flow out about 4 miles of the worst portion of the rapids. In 1881 and 1882 Congress appropriated \$50,000 for this work.

In the fall of 1882, Maj. C. J. Allen suggested locating the lock and dam at Buffalo Neck, about 8½ miles below Major Farquhar's site. This would necessitate a greater lift, but would flow out a longer reach of the rapids and reduce the dredging. The preliminary estimate of cost was placed at \$240,992.85. In 1883 a survey was made of the rapids, a report on which was submitted January 21, 1884. In that report Major Allen presented the cost of three plans for improving the rapids as follows:

(1) Locks and dams at Buffalo Neck and Isabella Island.....	\$476,378.49
Dredging	4,750.00
	<u>481,128.49</u>
(2) Lock and dam at Buffalo Neck	261,378.49
Dredging	12,750.00
	<u>274,128.49</u>
(3) Dredging the bars on the rapids and utilizing the dredged material for dams, training walls, etc	30,000.00

The officer favored the third plan and suggested for consideration the advisability of rendering the appropriations already made for a lock and dam available for dredging, and the river and harbor act of Congress approved August 5, 1886, authorized such expenditures in the following words:

Improving Red River of the North, Minnesota: Continuing improvement from Breckenridge to the northern boundary line of the United States, including dredging, removal of snags and boulders, and construction of wing dams, etc.; and the money heretofore appropriated for locks and dams is hereby made available for this purpose.

The balance from the appropriations for lock and dam was accordingly transferred to the improvement of the Red River of the North.

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At and in the vicinity of Goose Rapids the Red River of the North runs through a plain of soft alluvium underlaid with clay. At scattering intervals on this plain occur small deposits of drift in the shape of small bowlders, cobblestones, and gravel, composed of several varieties of crystalline rocks and a well-defined fossiliferous limestone. At Goose Rapids the river cuts through a number of these deposits, and the removal of the soft material has left the drift imbedded in the clay upon the bottom to such an extent as to prevent further cutting of the clay, and hence at low-water stages there is quite an increase in the river slope.

	Ft. per mile.
Average slope at low water over the whole reach at Goose Rapids, a distance of 22 miles.....	1
Greatest slope at any one point at low water over a distance of .928 mile	4.95
Slope of Red River over a distance of 154 miles above and below Goose Rapids and including same	0.54

From the foregoing it is perfectly evident that a lock and dam would not only be an unnecessary block in the navigation of the river, but that it would be an unnecessary expense. By removing the drift and clay which are the cause of the obstruction at this point the excessive slope can be so distributed as to no longer prove a hindrance to navigation. This is the project under which the improvement of the river is now being conducted.

I have therefore to report that in my judgment the Red River of the North, at Goose Rapids, is not worthy of improvement by means of a lock and dam.

COMMERCIAL STATISTICS.

[See Annual Report for fiscal year ending June 30, 1890.]

There are two steamboat lines now on the Red River: At Fargo, N. Dak., the Grandin Line; one steamer, *The Grandin*, 220 tons, with 4 barges, 2 of 300 tons, 1 of 250 tons, and 1 of 200 tons. At Grand Forks, the Red River Transportation Company, 2 steamboats; the *Pluck*, 36 tons, and the *H. W. Alsop*, 157 tons, with 10 barges; 4 of 198 tons, 1 of 202 tons, 1 of 155 tons, 1 of 116 tons, and 3 of 72 tons.

Comparative statement of freight moved by steamboats and barges during the past 11 years.

	Tons.		Tons.
1889.....	3,866	1883.....	25,314
1888.....	12,140	1882.....	31,652
1887.....	10,405	1881.....	26,557
1886.....	10,507	1880.....	21,651
1885.....	23,043	1879.....	17,859
1884.....	29,046		

Very respectfully, your obedient servant,

W. A. JONES,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, February 26, 1891.

Respectfully forwarded.

I concur in the opinion that "Red River of the North, with a view of improving the navigation of the same by the construction of a lock and

dam at Goose Rapids," is not worthy of improvement by the General Government.

O. M. POE,
Colonel, Corps of Engineers,
Division Engineer, Northwest Division.

B B II.

PRELIMINARY EXAMINATION OF CREEL'S BAY, TOTTEN BAY, AND MINNEWAUKEN SHOALS, IN DEVIL LAKE, NORTH DAKOTA, WITH AN ESTIMATE OF THE COST OF IMPROVING THE SAME BY DREDGING OR OTHERWISE, SO AS TO REESTABLISH THE NAVIGATION OF SAID LAKE.

[Printed in House Ex. Doc. No. 293, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 3, 1891.

SIR: I have the honor to submit the accompanying copy of report dated February 24, 1891, from Maj. W. A. Jones, Corps of Engineers, giving results of preliminary examination of Creel Bay, Totten Bay, and Minnewauken Shoals, in Devil Lake, North Dakota, "with an estimate of the cost of improving the same by dredging or otherwise, so as to reestablish the navigation of said lake," made to comply with provisions of the river and harbor act approved September 19, 1890.

Both Major Jones and Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division, report that in their opinion these localities are not worthy of improvement by the General Government, and I concur in the conclusions reached by these officers.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF MAJOR W. A. JONES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., February 24, 1891.

GENERAL: I have the honor to report having made an examination of "Creel Bay, Totten Bay, and Minnewauken Shoals, in Devil Lake, North Dakota, with an estimate of the cost of improving the same by dredging or otherwise, so as to reestablish the navigation of said lake."

Devil Lake lies wholly within the State of North Dakota, and its waters have no communication whatever with the waters of any other State. It can not, therefore, be classed among the navigable waters of the United States, and hence I do not see how it can be considered as a worthy subject of improvement by the General Government.

Very respectfully, your obedient servant,

W. A. JONES,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, February 26, 1891.

Respectfully forwarded.

From the statements hereto attached it does not appear that either the present or prospective commerce of Devil Lake is sufficient to justify the very considerable cost of the dredging that would be required at Creel Bay, Totten Bay, and Minnewauken Shoals, to obtain even a temporary improvement.

For this reason, and not for that assigned by Major Jones, United States Engineers, I am of opinion that the localities named are not worthy of improvement by the General Government.

O. M. POE,
*Colonel, Corps of Engineers,
 Division Engineer, Northwest Division.*

COMMERCIAL STATISTICS.

DEVIL LAKE, *December 17, 1890.*

Whereas by reason of the receding the past few years of the water in Devil Lake, the business of navigation has very materially decreased, and our business interests materially suffer thereby,

Resolved, That it is the sense of this Chamber of Commerce that the United States Government should, by a system of dredging or otherwise, seek to so improve the navigation of Devil Lake Bay as to permit the steamers to land at their former landing place; and second, to inquire into the feasibility of turning Mouse River into Devil Lake by means of a canal for the joint purpose of increasing the volume of waters into Devil Lake, and for irrigation purposes along the line of the proposed canal; third, to inquire into the feasibility of turning the waters of the Missouri River into the Mouse River for irrigation and navigation purposes, thence by the canal into Devil Lake for a storage reservoir of surplus water, then down the Cheyenne for irrigation purposes, thence into the Red River of the North for improving navigation thereon. We believe that the great volume of water which flows from the Mouse River at June or spring floods could be turned into Devil Lake, and would restore the latter to its former height, and if continued on to the Red River would make that stream of much greater commercial importance, and would help solve the irrigation problem for the farmers along the course of these streams.

Resolved, That we have carefully read over the statement submitted by Capt. E. E. Heerman to Maj. William A. Jones, of the United States Engineering Corps, relative to the rainfall and lowering of the lake, and the consequent decline in business, and that we know these statements are true in every particular, and earnestly urge some action by the Government to improve navigation on our lake.

A. O. WHIPPLE,
President.
 JAS. V. BROOKER,
Secretary.

DEVIL LAKE, N. DAK., *December 15, 1890.*

DEAR SIR: On May 27, of 1883, the first steamer in running operation, the steamer *Arrow*, was put on the lake at expense of \$5,800. On the 4th of July of the same year the steamer *Minnie H.* was put on the lake at a cost of \$32,000, it is about 160 tons burden, and since that time there has been another boat put on at an expense of about \$1,800. The first two boats since their first launching have been running continuously from opening until close of navigation each year, but, owing to the decline in business since 1887, they have been run at a great loss. Unless there is something done to bring the boats back to the old landing at Devil Lake, they must be abandoned, much to the inconvenience of the public at large, particularly that of the farmer residents on the south shore, and to the great financial loss of the owner.

The following is a correct record of the freight tonnage, Heerman line of steamers, Devil Lake, N. Dak., for the years 1887 to 1890, inclusive:

In 1887 the tonnage aggregated 1,339,368 tons, as follows:

	Pounds.
From the railroad.....	1, 635, 510
Frank Palmer, Indian trader, and miscellaneous freight.....	114, 510
Settlers' supplies.....	100, 000
Lime and lumber.....	27, 600
W. S. Peck, post trader, and miscellaneous freight.....	20, 500
13,000 bushels wheat.....	780, 000
Total.....	2, 678, 120

In 1888 the business fell off on account of low water, and not more than 800 tons of freight was carried. In 1889 the freightage did not exceed 600 tons, and in 1890 the tonnage fell to 300 tons. From 1883, when there was nothing done on the lake, the freight tonnage and passenger traffic steadily and rapidly increased each successive season, reaching maximum figures 1887, as above set forth. Since the last-named date, owing almost entirely to the falling of the lake, the decrease in tonnage has been even more marked than was the previous ratio of increase, declining from 1,300 tons in 1887 to 300 tons in 1890. The passenger traffic had also steadily increased in like ratio from 1883 to 1887, reaching its maximum figure in 1887, when, in the absence of any special record kept, I should estimate that we transported fully 3,000 passengers, while during the past season of 1890 we have not carried to exceed 1,000 passengers. By reason of the low stage of water our steamers each year since 1887 have had to land at improvised docks each season farther removed from the city of Devil Lake than the preceding year, so that now freightage and passengers must be transported by wagons and stages over a rough road around the bay, a circuitous route of over 3 miles, to the present landing. This materially adds to the cost of freight transportation, and not only to the cost but very greatly to the discomfiture of pleasure tourists and the business public generally. Had the waters not receded it is an apparent fact that instead of decreasing in volume the business of navigation on Devil Lake would have each year increased in a ratio similar to the rapid development of the tributary country, the great increase of population, and the growing popularity of the lake as a summer resort. The city of Devil Lake is the natural trade and financial center of a vast tributary region.

I respectfully submit herewith, as establishing the foregoing facts, a few brief letters from our more prominent business firms.

Maj. W. A. JONES,
Corps of Engineers, U. S. A.

LETTER OF MR. J. E. GALEHOUSE.

DEVIL LAKE, N. DAK., *December 10, 1890.*

DEAR SIR: Since the water in Devil Lake has fallen so that steamers can not land within about 3 miles of our place, the travel across the lake has greatly diminished, and is yearly losing its attractiveness as a summer resort.

If the bay could be dredged so as to let steamers land near our town, it would add largely to the traffic across the lake.

Most truly,

J. E. GALEHOUSE.

Maj. W. A. JONES,
Corps of Engineers, U. S. A.

LETTER OF MR. ED. I. P. STAEDT.

DEVIL LAKE, N. DAK., *December 6, 1890.*

DEAR SIR: I am pleased to address you in the matter of what advantage may accrue to our business interests if navigation on Devil Lake could be so improved as to allow steamers to land near our city, as in other years, for I consider that since the water fell to any considerable extent in the lake that the mercantile business in this city has steadily decreased. In my own line of trade, I am safe in estimating that in 1887—when the lake business reached its maximum point—my trade from the south side of the lake, settlers in Benson, Eddy, and even more remote counties, ag-

gregated \$10,000, while during the past farming season less than \$500 has come from that source. In earlier years the farmers could come in the steamer within a few squares of our city, and their purchases of machinery and other merchandise—often of heavy bulk—were easily loaded on to the boats to Fort Totten, where their own teams were in waiting; whereas now the only practicable way for the south-shore settlers to come here for supplies is to come over and around the lake, a distance from 50 to 91 miles, a journey so tedious and expensive that with very few exceptions they have discontinued trading here, and trade at their small trading stations. I formerly had a large business along the Sheyenne River and country tributary to Minnewauken, which trade has all disappeared since the steamboats ceased to make their regular trips. I consider that with the increased population of the country, that if the boats were running regularly over the lake and could land at the old dock, I would have a business of not less than \$2,500 annually from the Sheyenne farmers alone; as people would naturally come here, as they can buy for less money and have better stocks to assort from than they can find at any of their interior trading points over the lake.

Very respectfully, yours,

ED. I. P. STAEDE.

Maj. W. A. JONES,
Corps of Engineers, U. S. A.

LETTER OF MESSRS. WARNER & CLEVELAND.

DEVIL LAKE, November 25, 1890.

DEAR SIR: In reply to yours of recent date in regard to our present trade and what it formerly was when the steamers came to the docks of this city, would say that it has fallen off more than 1,000 per cent. Our trade in 1885-'86-'87 was large, now it is small in comparison. Taking our lumber, coal, and machinery which used to run up in the thousands have dropped into hundreds, and below that even. We know our trade would increase over the above percentage now if the steamers could land at our docks.

Respectfully, yours,

WARNER & CLEVELAND.

Capt. E. E. HEERMAN.

LETTER OF MESSRS. C. & L. BUDDE.

DEVIL LAKE, N. DAK., December 2, 1890.

DEAR SIR: Since about 2 years ago the water in Devil Lake has receded nearly out of the bay so that steamboats land so far away from our town that it has damaged our trade considerably.

I came here in the spring of 1883. From that time until the fall of 1888, when the firm of C. & L. Budde dissolved, we had considerable trade from south of Devils Lake and from along the Sheyenne River. Farmers were seen every day in our town. I think and believe that in the time mentioned, 4 to 5 years, when boats brought us the trade to our dock at the head of the bay, that during that time C. & L. Budde sold at least far over \$75,000 worth of lumber, machinery, and general merchandise across the lake.

Since the year 1888 there is so large a falling off from the trade across the lake, which is mostly due to the low water, having to haul goods about 3 miles to the nearest boat landing, also the same trouble in landing on the other side of the lake. We wish something could be done to improve navigation; our lake filled with water again would benefit our country and people.

Yours, truly,

C. & L. BUDDE.
C. BUDDE.

Maj. W. A. JONES,
Corps of Engineers, U. S. A.

LETTER OF MR. E. J. CHAMBERLIN.

DEVIL LAKE, N. DAK., December 3, 1890.

DEAR SIR: In the matter of our lake and the proposed dredging of bay, I notice that in the years when boats landed in the town we had a business of \$5,000 to \$7,000 from the country south of the lake, through dealers and at retail, which has de-

creased to about 30 to 35 per cent. of former amount, and from no other cause than the inaccessibility of our market under present condition of the water. The trade of our town has increased generally in other directions, and fallen of from this source. Devil Lake is and always has been the commercial center of this whole northwest country from natural location and surroundings, and it becomes an unfortunate matter to find our opportunities diminish from a cause to be remedied, but not by ourselves alone. Being the only sheet of water of any magnitude in the State, if made accessible, we will find ourselves a summer resort for the whole State.

Yours, truly,

Maj. W. A. JONES,
Corps of Engineers, U. S. A.

E. J. CHAMBERLIN.

LETTER OF MR. F. W. COCKBURN.

DEVIL LAKE, N. DAK., *December 17, 1890.*

DEAR SIR: I would say in regard to the position that we are in here on account of low water in our bay preventing steamboat navigation to the city, that it has been and will be a great detriment to us unless something is done. To myself personally it has not only caused me a great deal of extra expense, but also inconvenience. I do business at Fort Totten as well as here. While the steamboats ran up to the city I could in the warmest weather run my meats over to supply Fort Totten. Now I have to drive my stock 40 miles and keep extra help at the fort.

Hoping something will be done to help us out of this difficulty,
I remain, yours, respectfully,

F. W. COCKBURN.

Maj. W. A. JONES,
Corps of Engineers, U. S. A.

LETTER OF MESSRS. SOUTH & KELLY.

DEVIL LAKE, N. DAK., *December 17, 1890.*

DEAR SIR: In regard to the loss in trade from the south side of the lake since the steamer has been unable to get up to the dock, we can say that we formerly supplied that whole country with hardware, also the post traders at Fort Totten; but since the boat has had to land 4 or 5 miles from this place we have lost all the trade we had on the south side of the lake, which amounted to several thousand dollars a year. The people on that side of the lake would trade here if there was any way they could get over here and get their goods back without too much expense, and we would have had no difficulty in getting their trade if the boat could land at the dock.

Respectfully,

SOUTH & KELLY.

Maj. W. A. JONES,
Corps of Engineers, U. S. A.

APPENDIX C C.

PRELIMINARY EXAMINATION OF MISSOURI RIVER, FROM THE OLD MOUTH OF THE PLATTE RIVER, LITTLE POINT, TO A POINT OPPOSITE THE CITY OF LEAVENWORTH. ALSO OF THE RIVER AT THE CITY OF WESTON, MISSOURI, WITH A VIEW OF RETURNING SAID RIVER TO ITS ANCIENT CHANNEL, AND THE BEST PLAN OF ACCOMPLISHING THE SAME.

REPORT OF LIEUTENANT-COLONEL CHARLES R. SUTER, CORPS OF ENGINEERS, OFFICER IN CHARGE.

MISSOURI RIVER COMMISSION,
OFFICE OF THE PRESIDENT,
St. Louis, Mo., April 29, 1891.

GENERAL: In accordance with your instructions of September 24, 1890, I have the honor to forward herewith a map of the Missouri River from Port William, Kans., to Parkville, Mo., which covers the two portions of the river assigned to me for examination, viz:

Missouri River, from the old mouth of the Platte River, Little Point, to a point opposite the city of Leavenworth. Also of the river at the city of Weston, Mo., with a view of returning said river to its ancient channel, and the best plan of accomplishing the same.

This report has been delayed till the map of a resurvey of the Missouri River, made last fall, became available.

Upon the inclosed map I have indicated the extent and general character of the work needed to improve the river thoroughly over the designated portion, and in the case of Weston to restore the old channel past the town, the work in both cases conforming to the practice generally followed on the Missouri River, and embracing both permeable dikes for contracting and fixing the channel and bank revetments. The proposed lines of rectification are shown by broken lines, the dikes proposed by solid lines, and the proposed bank revetments by the letters R, R¹, R², etc.

The estimated costs are as follows, viz:

- | | |
|---|------------|
| (1) Improving Missouri River from the old mouth of the Little Platte River (about 1 mile above Parkville) to a point opposite the city of Leavenworth | \$800, 000 |
| (2) Improving the Missouri River at the city of Weston, Mo., with a view to returning said river to its ancient channel | 384, 000 |

With regard to the first item of work it may be said that it forms a part of the systematic improvement of the Missouri River, and should

not be considered apart from it. There would be no advantage conferred on navigation by work done here till the improvement is completed to Kansas City. No boats run above Kansas City at present.

The second item is of doubtful utility in any case, and would be a work of great difficulty and expense. At present there is no navigation here, nor prospect of any, so that the deprivation of its river landing is not likely to work much injury to the town of Weston. No appropriation is recommended in either case.

Very respectfully, your obedient servant,

CHAS. R. SUTER,
Lieut. Col. of Engineers,
President Missouri River Commission.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

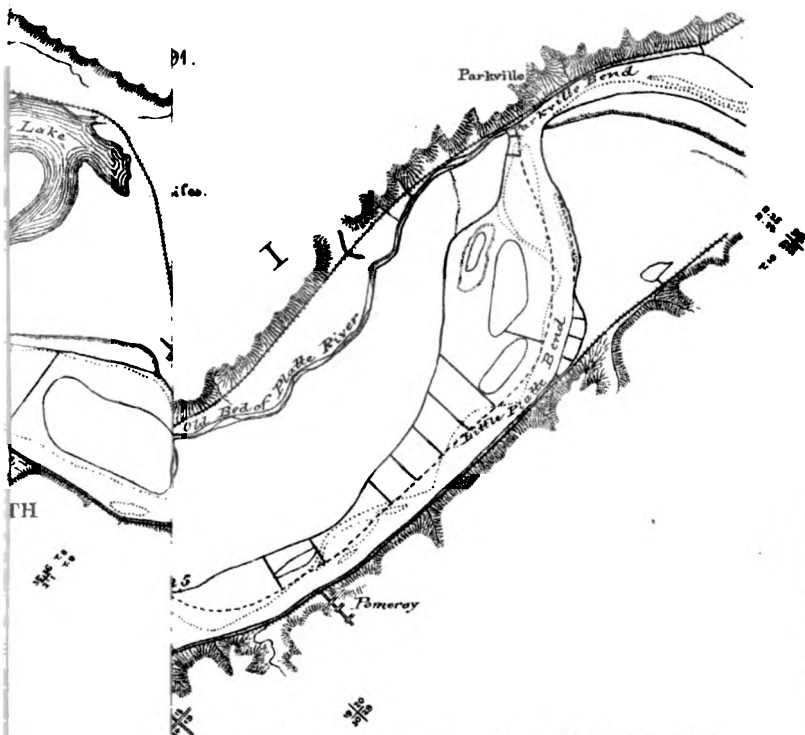
[Second indorsement.]

MISSOURI RIVER COMMISSION,
St. Louis, Mo., May 5, 1891.

Respectfully returned to the Chief of Engineers, U. S. Army.
The localities named are not considered worthy of improvement.

CHAS. R. SUTER,
Lieut. Col. of Engineers,
President Missouri River Commission.

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To accompany report of April 29, 1891.

Chas. R. Suter
Lt. Col. Engs. U.S.A.

Eng 91

APPENDIX D D.

IMPROVEMENT OF MISSOURI RIVER ABOVE SIOUX CITY, IOWA, AND OF YELLOWSTONE RIVER, MONTANA AND NORTH DAKOTA.

REPORT OF CAPTAIN CHARLES F. POWELL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|---|---|
| 1. Missouri River between the Great Falls, Montana, and Sioux City, Iowa. | 2. Yellowstone River, Montana and North Dakota. |
|---|---|

EXAMINATIONS AND SURVEYS.

- | | |
|---|---|
| 3. Tongue River, Montana, with a view of determining the practicability and approximate cost of straightening the channel of said river, immediately west of Miles City and north of the Northern Pacific Railroad track. | mouth to the mouth of Tongue River. |
| 4. Yellowstone River, Montana, from its | 5. Missouri River between Sioux City, Iowa, and Fort Benton, Montana, including the part of the river from the mouth of the Big Sioux River to the north line of the State of South Dakota. |

ENGINEER OFFICE, UNITED STATES ARMY,
Sioux City, Iowa, July 6, 1891.

GENERAL: I have the honor to transmit herewith reports upon the river improvements in my charge for the year ending June 30, 1891.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

D D I.

IMPROVEMENT OF MISSOURI RIVER BETWEEN THE GREAT FALLS,
MONTANA, AND SIOUX CITY, IOWA.

This work had been under the control of the Missouri River Commission. In compliance with orders, I received charge of the work November 29, 1890.

The project of improvement then in force consisted in contraction works and dredging at the bars on the rocky river, viz, from Fort Benton to Carroll, Mont., about 168 miles. A detailed survey throughout the whole reach, about 1,500 miles long, was also in progress. Snagging work on the sandy river, that from Carroll to Sioux City, had been recommended but not commenced. No work had been proposed from Fort Benton, the head of navigation, to the foot of the Great Falls, about 40 miles.

At the beginning of the year the vessels and other plant belonging on the rocky river were laid up from want of funds, having been hauled out on the bank at the end of the previous season; the field work of the triangulation between river bluffs had been completed; the primary levels carried from an assumed base at Fort Benton to Trovers Point, 232 miles, and the topography and hydrography run from Benton to Coal Banks, which part of the survey was being extended by a field party. This party closed work for the season at Wolf Point, Montana, 382 miles from Benton, and also set and ran the ordinary levels to permanent benches from Trovers to Wolf Point. The river survey from Benton to Coal Banks had been mapped in five charts, scale 1:12000, and on one chart, scale 1 inch to 1 mile.

During the year and since November computation and adjustment of the triangulation were completed at the office of the Missouri River Commission, with some aid from funds in my hands. The other field work has been reduced at this office, and two series of maps projected, one of preliminary charts, scale 2 inches to 1 mile, and the other detail charts, scale 1 inch to 400 feet. The preliminary charts, 8 in number, from Benton to Wolf Point, were completed in pencil; charts Nos. 1 and 2 were traced and blue printed. The detail charts, 63 in number, and covering the same reach, were plotted in pencil and their shorelines and contours inked; soundings, elevations, and names of places were printed on the 30 charts from Coal Banks to Trovers and the topographical signs on the first 7 of this set. It is expected, with funds in hand, to finish the two series of maps to the end of the present season's field work and to publish the detail charts by photolithography, reducing the scale one-third; below the mouth of the Yellowstone the scale of the charts is to be 1 inch to 600 feet, reducing one-fourth therefrom in publication.

It is also expected to carry this season the last of the field work to a point below Bismarck, N. Dak. Two large hydrographic and topographic parties were ready on June 30 to take the field, one commencing at Wolf Point and the other about 50 miles below Williston, N. Dak. The primary levels were run from Trovers to Poplar, and rerun from Coal Banks to Trovers, where they had not previously been duplicated and where there seemed to be need of a checking up.

The fleet belonging to the rocky river improvement was thoroughly repaired and launched; the dredge boat was lengthened to decrease its draft and more powerful steam capstans added; new capstans were also put on the towboat *Josephine*, and the small steamer *Little Joe* lengthened; part of the old barges, which were badly worn and decayed and

were too large, were broken up, and good parts, with new material, worked into scows of more convenient size and draft.

The dams at Bakers Bar, Evans Bar, and Fontanelle Bar were considerably repaired and extended; further extension is required at Bakers Bar and rock ballast on dams of the Fontanelle system; after doing that it is expected, with funds in hand, to continue the repairs to present dams, working downstream, and to build new works for contraction of water way and for holding up the water below rapids, and to dredge at the worst places as far as Judith, 87 miles from Benton.

To carry out the project in the application of the present appropriation for snagging, etc., and temporary improvement at the worst bar channels on the sandy river, a fully equipped snag boat and a snag scow, both of steel hulls, have been built, and will be ready for service in a few weeks and as soon as present high water subsides. The boats are to work principally between Sioux City and Berthold, about 850 miles up stream; the steamer *Josephine* is to be further fitted for pulling snags and removing other obstructions, and will work from Carroll to Berthold as soon as she can be spared from the rocky river.

Examinations were made for the selection of sites for two ice harbors, contemplated in the appropriation act, and two certain places recommended for that purpose. It is proposed to improve these places for the harbors as may be ordered.

The proposed application of the appropriation asked for 1893 is as follows:

Completion of the river survey and publication of maps	\$74, 497
Continuation of work on the rocky river	25, 000
Operation of snag boats and temporary improvement at the worst bars on the sandy river	50, 000
Rectification of the river at and near Pierre and Yankton, S. Dak	150, 000
Total	299, 497

The object of the intended work at Pierre and Yankton is to reclaim the steamboat landings. The landing at Yankton has been ruined and the one at Pierre injured by a shifting of the channel to the opposite side and a consequent extensive filling along the river fronts of the towns. The works would be useful in a subsequent permanent improvement of the river channel; in any plan for that the river fronts of the more important towns ought to be controlling elements where practicable, as it is in the cases named.

It is recommended that the estimate for the removal of snags, wrecks, and other obstructions and for temporary improvement at the shoalest channels be made as a separate appropriation, and in order that the work may be uninterrupted that the appropriation be made continuous, the same as for the operation of snag boats and dredge boats on the Upper Mississippi, and for the operation of snag boats on the Lower Mississippi and Ohio Rivers, as provided in the river and harbor acts of 1888 and 1890.

Money statement.

Amount appropriated by act approved September 19, 1890	\$300, 000. 00
June 30, 1891, amount expended during fiscal year*	32, 103. 89
July 1, 1891, balance unexpended	267, 896. 11
July 1, 1891, outstanding liabilities	\$12, 459. 77
July 1, 1891, amount covered by uncompleted contracts....	53, 057. 25
	65, 517. 02
July 1, 1891, balance available	202, 379. 09

* Exclusive of expenditures from balances in hands of Missouri River Commission.

2234 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

{ Amount (estimated) required for completion of existing project\$299,497.00
 Amount that can be profitably expended in fiscal year ending June 30, 1893 300,000.00
 Submitted in compliance with requirements of sections 2 of river and
 harbor acts of 1866 and 1867.

Abstract of proposals for charter of light-draft towboat for improving Missouri River, received and opened June 13, 1891, by Capt. Chas. F. Powell, Corps of Engineers.

No.	Name and address of bidder.	Name of steamer.	Price per day.
1	Southern Transportation and Lumber Co., St. Louis, Mo.	Little Eagle, No. 2	\$56.00
2	E. W. Durant and R. J. Wheeler, Stillwater, Minn.	R. J. Wheeler	125.00
3	John M. Turner, Mandan, N. Dak.	Abner O'Neal	53.50
4	Isaac P. Baker, Bismarck, N. Dak.	Rosebud	50.00
5	Grant Marsh, St. Louis, Mo.	Batchelor	
6	V. A. Bigelow, La Crosse, Wis.	R. A. Speed	80.00
7	Scott & Wallace, Paducah, Ky.	Jessie B.	66.00
8	George Hays, St. Paul, Minn.	Hiawatha	100.00
		Mike Davis.	49.00

* At rate of \$1,350 per month, or at that rate per day if delivered above, and \$5 per day additional if delivered below Omaha, Nebr. Award made to Isaac P. Baker for steamer *Rosebud*.

REPORT OF MR. H. C. GOULD, ASSISTANT ENGINEER.

U. S. STRAMER JOSEPHINE, *June 29, 1891.*

SIR: I have the honor to submit the following report of the season's operations to June 30, 1891:

Repairs to dams.—This work commenced April 7 at Fontanelle Bar. In the chute on the left side the bank had been cut away, taking off 48 feet of the outer end of dam No. 4 and in places the top of the dam was washed out; on dam No. 3 some brush and gravel were washed off the top.

The washed out places were refilled by brush fascines, weighted with gravel in sacks, and the whole length covered with loose gravel. A new part was built starting from a point on No. 4, 100 feet from the bank and extending to near the end of dam No. 5. This part is 172 feet long, averages 2 feet deep, and 20 feet wide at bottom; it was built in the usual manner, viz, laying brush fascines, about 1 foot in diameter; staking them firmly to the bottom and ballasting with gravel in sacks and covering the whole with loose gravel.

The following material and labor were used:

Stakes	number ..	158	Gravel	yards..	368
Fascines	do.....	429	Labor	days..	109
Gravel	sacks..	543			

At dam No. 1 was a deep cut around outer end and some holes were washed through the dam. A new piece 30 feet long was built from near outer end of the dam to the island as far below its head as practicable; about 10 feet of this was 3 feet deep, the rest averaging 1½ feet deep. The holes in the old part were filled.

There were used here:

Stakes	number..	40	Gravel	sacks..	587
Poles	do.....	50	Gravel	yards..	203
Fascines	do.....	170	Labor	days..	88

At dam No. 2 a deep hole had been worn by an eddy on the lower side at upper end; the wearing was stopped by placing 200 sacks gravel in and around the hole, requiring 21 days' labor.

On May 4 the dam-building party was established in camp at Bakers Bar. The old dam here was considerably washed out in places along the top. The end at mainland was threatened by cuts on both sides and at the island end a wide cut had been made. A very strong current was running over the whole dam. The high gravel dike thrown up by the dredge in 1889 across the head of the chute had been nearly all washed away.

Work was commenced at the mainland end; mats were built of brush fascines and poles, on a large barge, launched from the barge, and sunk along the dam by gravel in sacks and by rock. The barge was held by long lines reaching up the stream and was moved along the crest of the dam by lines from capstans on each end of the barge to the mainland and island respectively. As the work progressed, 180 feet of the outer end of the old dam was washed away and a large hole was cut in its place for about 120 feet; the part of the old dam which remained, 250 feet long, was raised

4 feet and from its end new work was put in for 400 feet, extending well up on the island; the ends were thoroughly protected.

The whole work was well ballasted with rock brought mostly from the La Barge Quarry, 55 miles below. There were used on this dam:

Poles	number..	284	Rock	yards..	426
Fascines	do.....	941	Lath yarn	coils..	4½
Gravel	sacks..	8,324	Labor	days..	632

The party was moved to Evans Bar June 25, and work started on the large dam there. The dam appears to be in good condition, none of it being washed away, but the water has cut around both ends. It is proposed to join one end to the main bank by substantial new work and extend the other end well up on the island, requiring about 3 weeks time.

It is expected that this will complete the repairs to dams above the Marias River.

Quarry work.—A dike of lava rock appears in the hills at Senieur Reach, 16 miles below Benton. Some rock for the dams had been taken from here in previous seasons. It appeared that sufficient rock could be obtained to justify opening it, and a hydraulic sluicing outfit was arranged with a large pump and material on hand; however, on being developed the dike reduced in thickness from 5 feet to 1 foot, was found to be mixed with much hard sand, and the surrounding material proved much harder to remove than was expected, so the place was abandoned. A trip was then made by the *Josephine* to examine the ledges about 20 miles above Benton. These were found to be of a sandstone, much of it too soft for use; on this account, and as the river above Benton is very difficult to navigate with a steamer as large as the *Josephine*, owing to the rapids and sharp turns, etc., it was decided to use the La Barge Quarry, where rock had been obtained in previous seasons; this is a hard, heavy, tough lava rock, and about 450 yards were already quarried. This amount was nearly all taken by June 15, and a party of 7 men and a cook was left there in camp to break up the boulders; this party was gradually increased until at the end of the month it had 15 men.

The following list shows the rock handled, where obtained, and where delivered:

Number yards.	Where from.	Where delivered.
23	Senieur Reach	Bakers Bar.
33	20 miles above Benton	Do.
370	La Barge	Do.
239	do	Evans Bar.
150 (estimated)	do	(Loading on 30th.)

Very respectfully, your obedient servant,

H. C. GOULD.

Capt. CHARLES F. POWELL,
Corps of Engineers, U. S. A.

Table of distances from River Survey.

Places.	Midway between banks.	Places.	Midway between banks.
	<i>Miles.</i>		<i>Miles.</i>
Fort Benton Bridge	0.0	Birds Rapids	113.7
Rowe Landing	11.8	Sturgeon Island	117.9
Marias River	21.0	Cow Island Landing	120.8
Coal Banks	40.5	Head of Grand Island	138.2
Sandy Creek	45.5	Head of Two Calf Island	142.9
Haystack Butte	50.0	Rocky Point	162.2
Eagle Creek	54.7	Carroll	168.4
La Barge Rock	55.0	Head of Ryans Island	175.0
Castle Rock	56.0	Hawley Island Cut-off	185.0
Eagle Rock	58.5	Mouth of Musselshell River	204.4
Cathedral Rock	61.0	Head of Elk Island	223.1
Hole in the Wall	63.0	Trover Point	231.8
Steamboat Rock	68.1	Buffalo Shoals	245.1
Dark Butte	69.1	Round Butte	262.3
Pablos Rapids	72.1	Hell Creek	274.6
Arrow River	76.7	Little Dry Creek	295.4
Drowned Man Rapids	84.0	Fort Peck	318.9
Judith River	86.6	Dry Fork	321.5
Judith Post-office	87.2	Galpin Station	327.2
Holmes Rapids	90.8	Mouth of Milk River	337.6
Gallatin Rapids	95.9	Mouth of Elk River	367.1
Dauphin Rapids	101.0	*Wolf Point Agency	382.5
Lone Pine Rapids	108.2		

*Distance by steamboat channel is 394.9 miles.

COMMERCIAL STATISTICS.

Three boats of from 2½ to 3 feet draft when loaded, are running on the river, engaged mostly in carrying merchandise and supplies from Sioux City, Pierre, and Bismarck to the military posts and Indian agencies from Sioux City to Berthold, N. Dak., and to Judith and Fort Benton, Mont., and in collecting grain, wool, potatoes, hides, bones, etc., for delivery at railroad landings, and in carrying passengers and live stock.

Some of the small ferry boats, it is believed, occasionally carry loads for short distances off their ferry routes, but of which only part record is available.

There is no article of heavy traffic largely transported. A little prospect exists that ores from the part of Montana south of the river and tributary to it may be carried on boats to Kansas City. The lignite coal of North Dakota, veins of which crop out on the river above Bismarck, may in the future be carried by boats to the towns below Bismarck. The river bottoms are fertile and when settled and farmed will doubtless cause an active traffic on the river between railroad points. There are works at Yankton producing a Portland cement whose tests are equal to those of English and German Portland cements. The material for the Yankton cement, chalk-stone, and clay abound in large quantities and are said to show at places on the river above and below Yankton; the chalk certainly crops out from the river bluffs, and it seems that the cement industry, at least at Yankton, should be extensive, and the cement shipped down the river to Sioux City, Omaha, and other cities.

The tonnage amounts tabulated below do not include ferriage business:

River tonnage between Sioux City and Bismarck.

	Tons.
1887	6, 064
1888	6, 075
1889	16, 622

Between Bismarck and Fort Benton.

	Tons.
1887	7, 897
1888	6, 820
1889	2, 102

River traffic for 1890.

	Package and bulk freight.	Passen- gers.	Live stock.
	Tons.	No.	Head.
Sioux City to Bismarck	9, 735	4, 322	2, 974
Bismarck to Fort Buford	12, 467	184	43
Fort Buford to Fort Benton	11, 124	62	43

* Military and Indian supplies, merchandise, grain.

† Grain, merchandise, flour, feed, lumber.

‡ Merchandise, wool, ore.

D D 2.

IMPROVEMENT OF YELLOWSTONE RIVER, MONTANA AND NORTH DAKOTA.

This work was transferred to me by Maj. W. A. Jones, Corps of Engineers, October 17, 1890.

No operations were conducted during the year, except a preliminary examination required by a provision in the act of September 19, 1890.

The project of improvement is suspended in order that the whole matter might be reported to Congress, and for reasons given in Appendix X 2 to the Annual Report of 1887, by Capt. C. B. Sears, Corps of Engineers.

The appropriation asked for 1893 is for procuring a plant for dredg

ing and sluicing at the bars on the river below Glendive, to be used whenever steamboating on the river shall be resumed, as it is likely to be any year.

Money statement.

July 1, 1890, balance unexpended	\$11, 926. 45
June 30, 1891, amount expended during fiscal year	160. 25
July 1, 1891, balance unexpended	11, 766. 20
July 1, 1891, outstanding liabilities .....	. 71
July 1, 1891, balance available	11, 765. 49
<hr/>	
{ Amount (estimated) required for completion of existing project	106, 000. 00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	30, 000. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

There is no steamboating on the river; a brisk traffic formerly existed, which ceased in 1885 after the Northern Pacific Railroad penetrated Montana. Below Glendive there is no railroad in the Yellowstone Valley, and no prospect of there being any. Prospects exist for competing rail lines to reach Bismarck or Berthold from the east and which would probably use the rivers above for feeders. Without boating on the Yellowstone below Glendive, transportation here means a wagon haul to and from Glendive, or to and from a point on the Great Northern road and ferriage across the Missouri River. This railroad, coming from the east, strikes the Missouri on its north side at Williston, N. Dak., about 40 miles below the mouth of the Yellowstone, and again at Fort Buford, about opposite the mouth. It appears that there should, naturally, be local boating between Glendive and a Missouri River point to the Great Northern road, and perhaps also some river point further downstream, as Berthold or Bismarck, where a rail line from the east may terminate.

There is a line of settlements along the river from its mouth up, and a stage and mail road from Buford to Glendive.

The area of land below Glendive and between bluffs is about 200 square miles, of which some two-thirds is bottom and the remainder first bench land. The June river rise rarely covers the bottoms, but at places they are frequently submerged during spring breakups by back water from ice gorges.

Vegetation on bottom and bench lands is prolific until about the end of June, when the dry months commence. Without rain or irrigation farming is out of the question. The hot sun of July and August while damaging vegetation cures the luxuriant grass, making nutritious food for stock. Grazing is therefore the present principal industry, one product of which, wool, can advantageously be carried by boat. Lignite coal crops out in about 4 and 5 feet veins in the river banks, and pieces of coal as large as barrels and hogsheads have been seen on the bars or along the shores. The coal is apparently as good as that mined in eastern Montana or Dakota.

D D 3.

PRELIMINARY EXAMINATION OF TONGUE RIVER, MONTANA, WITH A VIEW OF DETERMINING THE PRACTICABILITY AND APPROXIMATE COST OF STRAIGHTENING THE CHANNEL OF SAID RIVER IMMEDIATELY WEST OF MILES CITY AND NORTH OF THE NORTHERN PACIFIC RAILROAD TRACK.

[Printed in House Ex. Doc. No. 118, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 23, 1890.

SIR: I have the honor to submit the accompanying copy of report dated December 9, 1890, by Capt. Charles F. Powell, Corps of Engineers, giving results of preliminary examination of "Tongue River, Mon-

tana, with a view of determining the practicability and approximate cost of straightening the channel of said river immediately west of Miles City and north of the Northern Pacific Railroad track," made to comply with requirements of the river and harbor act approved September 19, 1890.

It is the opinion of Captain Powell and of the Division Engineer, Col. O. M. Poe, Corps of Engineers, that the locality is not worthy of improvement, in which opinion I concur.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF CAPTAIN CHARLES F. POWELL, CORPS OF ENGINEERS.

BISMARCK, N. DAK., *December 9, 1890.*

GENERAL: I have the honor to report, from a preliminary examination which I made, that "Tongue River, Montana, with a view of determining the practicability and approximate cost of straightening the channel of said river immediately west of Miles City and north of the Northern Pacific Railroad track," is not, in my opinion, worthy of improvement.

The river is not navigated, and there is no present prospect of its being navigated. It empties into the Yellowstone River near Miles City and about 80 miles above Glendive, Mont. An existing project for the improvement of the Yellowstone from Glendive to its mouth is suspended. The Yellowstone, before its valley was penetrated by the Northern Pacific Railroad, was navigated to above the Tongue River; there has been no steamboating on the Yellowstone since 1882.

The difficulty at Miles City is that Tongue River north of the railroad track is cutting its bank in an already deep bend on the side of the municipality, and its continuance will seriously endanger private property, as it already does a small tract controlled by the city; the river forms the eastern boundary of the Fort Keogh military reservation, and the citizens desire that a cut-off be made on the reservation side.

The Government has a right of way over the small tract referred to, and maintains a ferry across the river at that point for the use of Fort Keogh. A stoppage of the bank cutting would render unnecessary a shifting of the ferry anchorages and road making up a 15 or 20 foot bank from time to time; the prevention of this small work is the only public convenience which would be subserved by the stoppage of the bank cutting and river shifting.

Appended is a letter from Colonel Swaine, commanding Fort Keogh, in answer to an inquiry from me in this connection.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, December 19, 1890.

Respectfully forwarded to the office of the Chief of Engineers.

I concur in the opinion of Captain Powell as herein expressed, that the channel of Tongue River, Montana, immediately west of Miles City and north of the northern Pacific Railroad track, is not worthy of improvement by the General Government.

O. M. POE,
*Colonel, Corps of Engineers,
 Division Engineer, Northwest Division.*

LETTER FROM COLONEL P. T. SWAINE.

FORT KEOGH, MONT., *October 19, 1890.*

SIR: In reply to your favor of the 15th instant I have the honor to inform you that neither the straightening of the Tongue River channel nor the improvement for navigation of the Yellowstone would be beneficial to the transportation or other facilities of the post.

I presume the work proposed on Tongue River is in the interest of the town of Miles City, as the bank on that side of the stream is gradually washing, and I have understood the subject was brought to the attention of the proper authorities in Congress or in the bureaus in Washington by the Congressional delegation representing this State.

Very respectfully, your obedient servant,

P. T. SWAINE,
Colonel, Twenty-second Infantry, Commanding.

Capt. CHAS. F. POWELL,
Corps of Engineers, U. S. A.

D D 4.

PRELIMINARY EXAMINATION OF YELLOWSTONE RIVER, MONTANA, FROM ITS MOUTH TO THE MOUTH OF TONGUE RIVER.

ENGINEER OFFICE, U. S. ARMY,
St. Louis, Mo., March 25, 1891.

GENERAL: I have the honor to submit the following report of a preliminary examination made by me of the Yellowstone River, Montana, from its mouth to the mouth of Tongue River:

The length of river named, at the upper end of which Miles City is situated, is 187 miles. Glendive is about half way, or 98 miles from the Yellowstone mouth. The mouth of the Big Horn, the principal tributary of the Yellowstone, is 106 miles above the mouth of Tongue River.

From about 1876 to 1881, and especially during the building of the Northern Pacific road in Montana, there was a brisk navigation on the Yellowstone; steamers have frequently ascended the Big Horn to Fort Custer, 40 miles, and a boat has gone up the Yellowstone to near the present town of Billings, or about 50 miles above the Big Horn. Two steamers went up the Yellowstone in 1882; there has been no navigation on the river since.

The river was surveyed in 1878 and 1879 from Junction City, 5 miles above the Big Horn, to Diamond Island, about 57 miles below Glendive, \$19,000 having been appropriated therefor. Work of improve-

ment, consisting of rock removal and building of dams and shore protection, was commenced in 1879 and continued to 1885; it was confined at first to the reach between Miles City and Glendive under a project to improve the low-water channel for light-draft navigation up to Miles City; part of the 1881 work and subsequent work were below Glendive, to which reach the project has been thereafter limited; in 1883 the survey was extended from Diamond Island to the mouth.

Upon an explanation of the inadequacy of available funds and recommendations of the engineer in charge, summarized in his annual report of 1887, the Chief of Engineers directed in July, 1887:

(1) That no construction work on the Yellowstone River be undertaken this season.

(2) That the present plant be put in repair, just sufficient to move it to the mouth of the Yellowstone, and add it to that of the Upper Missouri River, and to preserve it in storage until next season, awaiting the next season or further action of Congress.

Congress has not made any appropriation since nor taken any action other than to require the present examination. The project therefore remains suspended. In the mean time the working plant has been transferred to the Upper Missouri River improvement.

The work done was beneficial in deepening the channel and otherwise improving the navigation; that of the rock-removal part remains; the contraction and bank-protection works have been much damaged by ice and from other causes and are now generally in bad condition.

The total appropriation for the Yellowstone improvement, 1879 to 1886, is \$118,750, from which amount the expenses of the 1883 survey were paid; the available balance remaining is \$11,766.20.

I have to report that the Yellowstone above Glendive is not worthy of improvement, but that the part from Glendive to the mouth is worthy of improvement, and for the reason that there is no prospective river commerce for the upper part named, while there is a prospect for river traffic below Glendive. The North Pacific Railroad going west from the Missouri on a direct line strikes the Yellowstone at Glendive and closely follows it to beyond the head of navigation. From Glendive the river flows northeast and away from the railroad.

The much longer river route has not competed against the more direct and through rail line, and I have not been able to learn of any prospective traffic which would probably support boating on an improved river as against a railroad. The future rail tariff is likely to be reduced, while the small volume of water at low stage, which is a difficulty to present navigation, especially on the upper part of the Yellowstone, will probably be diminished from irrigation ditches and land clearing and cultivation, and the difficulty thereby increased.

Below Glendive there is no railroad in the Yellowstone Valley, and as far as I can see now no prospect of there being any; without boating, transportation here means a wagon haul to and from Glendive or to and from a point on the Great Northern road and ferriage across the Missouri River. This railroad, coming from the east, strikes the Missouri on its north side at Williston, N. Dak., about 40 miles below the mouth of the Yellowstone and again at Fort Buford, about opposite the mouth. It appears that there should naturally be local boating between Glendive and a Missouri River point of the Great Northern road, and perhaps also some river point farther downstream, as Berthold or Bismarck, where a rail line from the east may terminate.

There is a line of settlement along the river from its mouth up, and a stage and mail road from Buford to Glendive.

The area of land below Glendive and between bluffs is about 200 square miles, of which some two-thirds is bottom and the remainder first bench land. The June river rise rarely covers the bottoms, but at places they are frequently submerged during spring break-ups by back water from ice gorges.

Vegetation on bottom and bench lands is prolific until about the end of June, when the dry months commence. Without rain or irrigation farming is out of the question. The hot sun of July and August while damaging vegetation cures the luxuriant grass, making nutritious food for stock. Grazing is therefore the present principal industry, one product of which, wool, can advantageously be carried by boat. Lignite coal crops out in about 4 and 5 feet veins in the river banks, and pieces of coal as large as barrels and hogsheads have been seen on the bars or along the shores. The coal is apparently as good as that mined in eastern Montana or Dakota.

The average slope of the river below Glendive is $2\frac{1}{2}$ feet per mile, commencing with a 3-foot slope and ending with one of 2 feet. From Glendive to Diamond Island the river is gravelly; from Diamond Island to the mouth it is sandy. These two reaches are similar in character and degree of navigability, except that their islands and sloughs are more numerous and the ice gorges more damaging, to the reaches of the Missouri River from Cow Island to Carroll and from Carroll to Buford. The approved project on the Missouri above Carroll to beyond Cow Island, now under execution, consists of closing and wing-dams and dredging. Below Carroll no project has been proposed, other than snagging, although it has been recommended that dredging would be useful for some distance from Carroll.

The plan of improvement for the Yellowstone below Glendive to give a good 3 feet low-water channel should be closing dams where the river is divided at shoals, protection at cutting banks, and dredging at the gravel bars, near and above Diamond Island, and steamboat sluicing at bars on the sandy river. The dams, if maintained, and the dredging will give a fairly permanent channel. The sluicing will generally need to be repeated yearly.

The estimate of cost of this plan, derived from the survey maps and costs of past work of building of dams at the locality and from other sources, is—

20,700 feet of closing dams, at \$7.50	\$155,250
16,200 feet of revetment bank, at \$5	81,000
Plant therefor	15,000
Plant for dredging and sluicing	30,000
	<hr/>
	281,250

and after the first year for annual maintenance of works and the sandy river channel \$30,000.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer,
Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., March 28, 1891.

Respectfully forwarded to the Chief of Engineers.

I concur in the opinion herein expressed, that above Glendive the Yellowstone River, Montana, is not worthy of improvement by the General Government. Whether it is worthy of such improvement between Glendive and its mouth, 98 miles below, depends upon the probable relations between the cost and the benefits. If a probable expenditure of \$281,250 in first improving the river, and a subsequent annual expenditure of \$30,000 for maintaining the improvement, be a fair estimate (and I have no reason to doubt it), then, in my opinion, based upon the statement of the commerce as given by the Glendive committee, the present commerce, or that probable in the near future, is insufficient to justify the improvement of any portion of Yellowstone River by the General Government at this time. I will be prepared to modify this opinion whenever the conditions may seem to warrant it.

O. M. POE,
*Colonel, Corps of Engineers,
 Bvt. Brig. Gen., U. S. A.,
 Division Engineer, Northwest Division.*

STATEMENT OF GLENDIVE COMMITTEE.

GLENDIVE, MONT., *December 16, 1890.*

DEAR SIR: In reply to your favor of December 14, we would respectfully say that the advantages to the citizens and merchants of this county would be innumerable if we could navigate the Yellowstone River. In the years 1881 and 1882, when boats were running on the Yellowstone, the rates of freight from St. Paul, Minn., to Glendive, Mont., were reduced from \$2.50 for first-class freight, to \$1.10 for unclassified freight, which rate was maintained for two years.

With such competition all merchants and their patrons would be greatly benefited in shipping in goods, which amounted during the past year to over 300 cars, regardless of numerous small shipments. There were shipped from this county this past season 1,000,000 pounds of wool, 580 cars of cattle, and 200 cars of sheep.

There are several settlements along the Yellowstone between Glendive and Fort Buford which maintain a triweekly stage and mail line, which would be greatly benefited, as said residents are now compelled to transport all their freight and produce some 40 miles or more by wagons.

This county is rapidly settling up and freights will be largely increased during the coming year.

Yours, very respectfully,

Capt. CHAS. F. POWELL,
Corps of Engineers, U. S. A.

D. R. MEAD,
 H. HODGSON,
 JAMES G. RAMSAY,
Committee.

DD 5.

PRELIMINARY EXAMINATION OF MISSOURI RIVER BETWEEN SIOUX CITY, IOWA, AND FORT BENTON, MONTANA, INCLUDING THE PART OF THE RIVER FROM THE MOUTH OF THE BIG SIOUX RIVER TO THE NORTH LINE OF THE STATE OF SOUTH DAKOTA.

ST. LOUIS, MO., *October 21, 1890.*

GENERAL: I report that, in my opinion, the Missouri River between Sioux City, Iowa, and Fort Benton, Mont., including the part of the river from the mouth of the Big Sioux River (at Sioux City) to the

north line of South Dakota, the preliminary examinations of which were assigned to my charge by Department letter of September 20, 1890, are worthy of improvement, at least for the greater part of the reach of river named, and for the following facts and reasons:

The Missouri River from Sioux City to Benton, 1,716 miles, has been a natural highway for exploration, trade, military transportation, and settlement. It is about a one-sixth part of the immense system of Mississippi River navigable water ways. Although the navigation is not easy and convenient, this part of the river is free from falls, very serious rapids, and obstructive bridges. It has been navigated by steamboats throughout since 1860, when two steamers reached Fort Benton; in 1831 an Ohio River steamer arrived at Pierre, 642 miles above Sioux City; between these times steamboats have pushed further up the river as demands required. Within a year I have seen at Cairo a steamer intended for the upper Missouri River trade, loaded with iron ware at Pittsburg for Benton; that is, a carriage of an unbroken cargo from Pennsylvania to Montana.

The Missouri River from Benton downstream to Carroll, 160 miles, is known as the rocky river. Work under a project for permanent improvement on this part was undertaken by the Engineer Department several years ago, and has been continued by the Missouri River Commission, whose engineer in charge estimated in his late annual report that \$250,000 are required to complete the existing project and that \$125,000 could be profitably expended in the year ending June, 1892.

There has been no work done from Carroll to Sioux City, called the sandy river; the Missouri River Commission have recommended during the last 2 years snagging operations here, and have urged the appropriation of funds to complete a survey over this part for aid in preparing a project for permanent improvement, speaking of the reach as one unknown for engineering purposes and of the survey as of national importance.

The Engineer Department made a survey of the river from Sioux City to Pierre in 1879 to 1882; the Missouri River Commission have extended a triangulation over the whole part from Sioux City to Benton and have nearly completed the remainder of the field work of a systematic survey from Benton to Milk River, 350 miles. In fact, the Commission survey has extended in whole or in part, and was intended to be made complete, from the mouth of the river to Three Forks, 244 miles above Benton; their funds applicable to the survey from Sioux City to Benton are practically exhausted.

Bench marks, soundings, and new shore lines are desirable over the old part from Sioux City to Pierre, and are estimated for below with the new survey work, in addition to the unexpended balance of the allotment for the examinations:

Field work of topography, hydrography, and levels, Milk River to Pierre, 724 miles at \$92.50	\$66,970.00
Same of hydrography, levels, and shore lines, Pierre to Sioux City, 642 miles, at \$46.75	30,013.50
Mapping and publication, Benton to Pierre, 1,074 miles, at \$32.75	39,673.50
Same, Pierre to Sioux City, 642 miles, at \$20	12,840.00
Total	149,497.00

The class of survey intended is that which will simply answer present purposes; nothing less extended or detailed will do. The prices have been carefully scrutinized; consequently the estimate should not be curtailed.

The demands of river commerce above Sioux City during the last season, now at a close, were met, but not wholly, it is believed, by the services of three steamboats. Railroads have in late years paralleled the river and penetrated the region previously tributary to it, and have absorbed the traffic, which in 1881 and 1882 gave business to more than twenty steamboats. This is in line with the history of traffic on western water ways. The same history also shows that the growth of towns and the settlement of the country and increase of business very generally follow the advent of railroads; and, as a next stage, that articles in bulk and a low class of freights are furnished whose transportation seeks the river and calls for an easier navigation and a deeper channel, wherever practicable, and that local river lines to landings and settlements intermediate between railroad points become needful; also that some commercial interests require the maintenance of an improved river route as a regulator of rail rates.

There is no reason to judge that the same traffic history will not obtain on the Missouri from Sioux City upstream.

At the upper end of the river reach under consideration there is a question of practicability as to river improvement, and which I had in view when indicating at the beginning of this report the possibility that a smaller part of the river was not worthy of improvement. The volume of the rocky river at different low stages has been found to be only from 2,800 to 3,400 cubic feet per second, not enough for profitable sized boats; the low stage obtains for one-half of the time when the river is free from ice, leaving about three months for the navigable season and making it too short for commercial purposes. The cost of neutralizing the low-water difficulty may not pay for the resulting benefit. The survey is necessary to determine this question. Milk River and the Yellowstone are received below the rocky river; these tributaries more than double the volume of the rocky river; the Yellowstone has been navigated, and its lower 40 miles are without railroad facilities, and navigation is here called for, while a trunk rail line skirts the main river from near the mouth of the Yellowstone to Milk River. So that the mouth of the Yellowstone, 514 miles from Benton, forms a dividing line in the reach from Benton to Sioux City, below which line the river is more worthy of improvement than above.

It should be noted that a principal part of the field work of the river survey has been made at the upper end of the river, and I judge that sufficient warrant remains for navigation improvement purposes for completing the survey there. Besides, it is advantageous for other public interests that the Missouri River survey, now well advanced at both ends, should be made continuous from its headwaters to its mouth.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[Third indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., November 11, 1890.

Respectfully forwarded, with the following views and recommendation, viz:

I am not informed as to how far it is deemed advisable to attempt a general improvement of Missouri River above Sioux City. Results of any value beyond what may be obtained by removing snags and similar obstructions will, even if successfully accomplished, only be attained at a cost far in excess of any probable benefit.

I have grave doubts concerning the possibility of any permanent improvement of that portion which Captain Powell herein designates the "sandy river," but I have none as to the advisability of such a survey and examination as will serve as a basis for an intelligent opinion, which it seems to me is quite impracticable in the present state of our knowledge of the matter.

It is quite apparent that the funds at the disposal of the Department are insufficient to do more than pay for surveys of a small portion of the river within the limits designated in the law. The triangulation stations of the Missouri River Commission's survey will serve to put into position any detached surveys in case such are made, and gradually the whole may be brought together. Section 18 of the river and harbor act of September 19, 1890, requires that the division engineer of the locality shall report whether, in his opinion, the river is worthy of improvement, but does not require any expression as to the extent or character of such improvement. Believing that Missouri River between Sioux City and Fort Benton is worthy of improvement, at least to the extent indicated in the opening paragraph of this indorsement, I recommend that the survey herein proposed be authorized and that such allotment for the purpose be made from the appropriation now available as the condition of the funds will permit.

O. M. POE,
*Colonel, Corps of Engineers,
 Division Engineer, Northwest Division.*

PROJECT FOR IMPROVEMENT OF MISSOURI RIVER, NEBRASKA AND SOUTH DAKOTA, FROM THE MOUTH OF THE BIG SIOUX RIVER TO THE NORTH LINE OF THE STATE OF SOUTH DAKOTA.

ENGINEER OFFICE, UNITED STATES ARMY,
Sioux City, Iowa, July 3, 1891.

GENERAL: Having reported October 21, 1890, from the preliminary examination required by the act of September 19, 1890, that the Missouri River, from the Big Sioux River to the north line of the State of South Dakota, was worthy of improvement, and in compliance with Department instructions, I have the honor now to offer a plan of improvement for the water named, and an estimate of its cost, as follows:

- (1) Extension of present river survey and mapping and publication of maps:
- | | |
|--|----------------|
| Field work of hydrography, topography, and levels, boundary line to Pierre, 192 miles, at \$92.50 | \$17,760 |
| Same of hydrography, levels, and shore lines, Pierre to the Big Sioux River, 456 miles, at \$46.75 | 21,318 |
| Mapping and publication, boundary line to Pierre, 192 miles, at \$32.75 | 6,288 |
| Same, Pierre to Sioux City, 456 miles, at \$20 | 9,120 |
| | <hr/> \$54,486 |

(2) Removal of snags, wrecks, and other obstructions; temporary work and placing channel marks at the worst bar channels, and at the entrance to the winter harbor at mouth of the Big Sioux River, annually.....	\$25,000
(3) For rectification of the river at and near Yankton, S. Dak	75,000
(4) For rectification of the river at and near Pierre, S. Dak	75,000
Total	229,486

A principal reason for the postponement heretofore of a project for the permanent improvement of the Missouri River in South and North Dakota has been the absence of a survey. A continuous detailed survey from the Great Falls, Montana, is now in progress, and with present funds will be completed this year to a point between Bismarck, N. Dak., and the north line of South Dakota. The estimate for completion from this point to Sioux City (mouth of Big Sioux River) is \$74,497, which should be appropriated in order to make the survey continuous, as it ought to be, instead of the amount named for the part from the north line of South Dakota.

The annual removal of snags and other obstructions would be a judicious improvement and a great aid to navigation. A snagging plant is now being built from the present appropriation for improving the Missouri River from Sioux City to the Great Falls; its operation should be uninterrupted, the same as provided for by continuous appropriations for the removal of snags, etc., on the lower and upper Mississippi and the Ohio rivers in the river and harbor acts of 1888 and 1890. The temporary deepening of the worst bar channels and the marking of the channels before the completion of a permanent improvement, which will necessarily be a matter of several years, would also be a judicious work and will need to be repeated during each low water. The estimate for these annual temporary and continuous works on the sandy part of the Missouri above Sioux City is \$50,000, and about one-half the works will fall on the part of the river in South Dakota; the whole amount should preferably be appropriated and made applicable to the whole Upper Missouri.

The continuous permanent improvement of the Missouri River on its sandy part will be of great cost, and is not now, in my opinion, warranted by the present nor prospective commerce. Such improvement would most probably provide channels along the immediate river fronts at the principal towns; and work of rectification of the river done now at these places would be useful in a plan of proper and permanent river improvement.

There is need for the restoration of the steamer landings at Yankton and Pierre. At both places the channel has shifted to the opposite side, thereby causing extensive fills along the river fronts of the towns. There is no steamer landing at Yankton, while formerly a dozen boats or more used to land at a time at the immediate bank. At Pierre the landing is well above the town and is gradually filling up. There are two railroads belonging to large systems running into each of the towns named from the east, and doubtless bridges will be built across the river here, in extension of the roads to the Black Hills; it would be good to properly fix the channels before the bridges are built. The improvements estimated for at Yankton and Pierre consist in the deflection of the river by works above the towns to make the river flow along the town fronts. At Yankton the bank is of fairly hard material and bank protection will not be required. At Pierre the bank is not quite so good and it is likely that bank protection against caving will be

necessary. If the United States undertakes the bank protection \$25,000 should be added to my estimate above.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer,
Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., July 11, 1891.

Respectfully forwarded to the office of the Chief of Engineers.
I concur in the conclusions and estimates of this report.

O. M. POE,
*Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.*

COMMERCIAL STATISTICS.

Three boats are running on the river, carrying merchandise and supplies from the railroad points of Sioux City, Pierre, and Chamberlain, principally to the military posts and Indian agencies between Bismarck and Sioux City, and collecting grain, wool, hides, bones, etc., for delivery at railroad landings. There is no through traffic nor any article of heavy traffic largely transported. The lignite coal of North Dakota, veins of which crop out on the river above Bismarck, may in the future be carried by boats to the towns below Bismarck. The river bottoms are fertile and when settled and farmed will doubtless cause an active traffic on the river between railroad points. There are works at Yankton producing a Portland cement, whose tests are equal to those of English and German Portland cements. The material for the Yankton cement, chalk, stone, and clay, abound in large quantities and are said to show at places on the river above and below Yankton; the chalk certainly crops out from the river bluffs, and it seems that the cement industry, at least at Yankton, should be extensive, and the cement shipped down the river to Sioux City, Omaha, and other cities.

The only statistics of river tonnage available apply to the reach from Bismarck to Sioux City, 738 miles; the part from Sioux City to the north line of South Dakota being 648 miles. The amounts tabulated below do not include ferriage business, neither some small tonnage occasionally carried by ferry boats on short distances off their ferry routes.

River tonnage between Sioux City and Bismarck.

	Tons.		Tons.
1887.....	6, 064	1889.....	16, 622
1888.....	6, 075	1890.....	*9, 735
Number of passengers carried, 1890			4, 322
Head of live stock carried, 1890.....			2, 974

*Military and Indian supplies, merchandise, grain.

PROJECT FOR IMPROVEMENT OF MISSOURI RIVER BETWEEN SIOUX CITY, IOWA, AND FORT BENTON, MONTANA.

ENGINEER OFFICE, UNITED STATES ARMY,
Sioux City, Iowa, September 7, 1891.

GENERAL: Having reported that the Missouri River between Sioux City and Fort Benton was worthy of improvement, at least for its greater part, I have the honor now to offer the following plan and estimate of cost of improvement:

A project for improvement of the river from Fort Benton to Carroll, Mont., 168 miles, called the rocky river, has been under execution during several years. After the application of funds in hand for the purpose there will remain of necessary work the removal of bowlders and the dredging of hard material at rapids below Judith, which point is nearly half way from Benton to Carroll.

From Carroll to Sioux City, nearly 1,400 miles, the river is first sandy and then muddy and quickly assumes the bad characteristics of the Lower Missouri, and, in addition, is subject to damaging ice gorges. A satisfactory project for permanent improvement and an estimate of cost below Carroll await the completion of the systematic and detailed survey now in progress. A present need on the sandy and muddy river, whose work does not depend upon a survey, is the removal of snags, wrecks, and other obstructions; also, previous to the completion of permanent works, temporary improvement at the worst bars and the marking of the new channels by ranges on shore. The temporary work is to be done by steamer sluicing, and has for its object the opening of channels during low stages at the places of controlling depth for the steamboats navigating the river. The present appropriation for improving the Missouri River between the Great Falls and Sioux City will have provided the snag boats; their operations in snagging and sluicing should be uninterrupted, and to insure that the appropriation for their future operations should be made continuous, the same as for the operation of snag boats and dredge boats on the Upper Mississippi and for the operations of snag boats on the Lower Mississippi and Ohio rivers, as provided for in the river and harbor acts of 1888 and 1890.

The present appropriation is also to provide an ice harbor at Rock Haven, near Bismarck and Mandan, N. Dak., for the maintenance of which a small amount will be needed annually.

There is need of restoring the steamer landings at Yankton and Pierre, S. Dak., the works for which are not dependent upon the continuous survey. At both places the channel has shifted to the opposite side, thereby causing extensive fills along the river fronts of the towns. There is no steamer landing at Yankton, while formerly a dozen boats or more used to land at a time at the immediate bank. At Pierre the landing is well above the town and is gradually filling up. There are two railroads belonging to large systems running into each of the towns named from the east, and doubtless bridges will be built across the river here in extension of the roads to the Black Hills; it would be good to properly fix the channels before the bridges are built. The improvements estimated for at Yankton and Pierre consist in the deflection of the river by dikes above the towns to make the river flow along the town fronts. At Yankton the bank is of fairly hard material and bank protection will not be required. At Pierre the bank is not quite so good and it is likely that bank protection against caving will be necessary. If the United States undertakes the bank protection, \$25,000 should be added to my estimate below.

The hydrographic and topographic survey of the river now in progress, and based on a triangulation between bluffs and one between banks, and on a circuit of primary levels, will be extended by means of funds in hand to next below Bismarck, N. Dak., or more than half way from Fort Benton to Sioux City. The speedy completion of the survey and its mapping are highly judicious for public interests, and especially as a preliminary to the preparation of a plan for permanent channel improvement.

ESTIMATE OF COST.

Completion of necessary work on rocky river below Judith, Mont	\$50,000
Operation of snag boats and temporary improvement at the worst bars on the sandy and muddy river (annually)	50,000
Maintenance of ice-harbor at Rock Haven (annually)	5,000
Rectification of the river at and near Pierre and Yankton, S. Dak	150,000
Completion of river survey and publication of maps	74,497
Total	329,497

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division).

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., September 16, 1891.

Respectfully forwarded to the office of the Chief of Engineers with the following remarks:

Whatever protection is necessary to preserve the banks and thus maintain the improved channel of the river seems to be a legitimate charge against the sums appropriated by the General Government. But it is doubtful if this extends to the construction and maintenance of commercial levees, such as are usually found at all important landings. It is difficult to sharply define the limitations in the two cases, and thus separate what is properly a Government charge from one which is purely local. It therefore seems to me to be advisable to consider and act upon each particular case as it arises.

With the reservation indicated above, the project is recommended for approval.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

COMMERCIAL STATISTICS.

Three boats of from 2½ to 3 feet draft when loaded are running on the river, engaged mostly in carrying merchandise and supplies from Sioux City, Pierre, and Bismarck to the military posts and Indian agencies from Sioux City to Berthold, N. Dak., and to Judith and Fort Benton, Mont., and in collecting grain, wool, potatoes, hides, bones, etc., for delivery at railroad landings, and in carrying passengers and live stock.

Some of the small ferry boats, it is believed, occasionally carry loads for short distances off their ferry routes, but of which only part record is available.

2250 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

There is no article of heavy traffic largely transported. A little prospect exists that ores from the part of Montana south of the river and tributary to it, may be carried on boats from Judith to Kansas City. The lignite coal of North Dakota, veins of which crop out on the river above Bismarck, may in the future be carried by boats to the towns below Bismarck. The river bottoms are fertile and when settled and farmed will doubtless cause an active traffic on the river between railroad points. There are works at Yankton producing a Portland cement whose tests are equal to those of English and German Portland cements. The material for the Yankton cement, chalk-stone, and clay, abound in large quantities and are said to show at places on the river above and below Yankton; the chalk certainly crops out from the river bluffs, and it seems that the cement industry, at least at Yankton, should be extensive, and the cement shipped down to Sioux City, Omaha, and other cities.

The tonnage amounts tabulated below do not include ferriage business:

River tonnage between Sioux City and Bismarck.

	Tons.
1887	6, 064
1888	6, 075
1889	16, 622

Between Bismarck and Fort Benton.

	Tons.
1887	7, 897
1888	6, 820
1889	2, 102

River traffic for 1890.

	Package and bulk freight.	Passen- gers.	Live stock.
	<i>Tons.</i>	<i>Number.</i>	<i>Head.</i>
Sioux City to Bismarck	9, 735	4, 323	2, 974
Bismarck to Fort Buford	12, 467	184	43
Fort Buford to Fort Benton	1, 124	62	43

* Military and Indian supplies, merchandise, and grain.

† Grain, merchandise, flour, feed, and lumber.

‡ Merchandise, wool, and ore.

APPENDIX E E.

IMPROVEMENT OF TENNESSEE RIVER ABOVE CHATTANOOGA, TENNESSEE, AND BELOW BEE TREE SHOALS, ALABAMA; OF CUMBERLAND RIVER, TENNESSEE AND KENTUCKY, AND OF THEIR TRIBUTARIES IN EASTERN TENNESSEE AND KENTUCKY.

REPORT OF LIEUTENANT-COLONEL J. W. BARLOW, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|--|--|
| 1. Tennessee River above Chattanooga, Tennessee, and below Bee Tree Shoals, Alabama. | 5. Cumberland River, Tennessee and Kentucky. |
| 2. Hiwassee River, Tennessee. | 6. Caney Fork River, Tennessee. |
| 3. French Broad River, Tennessee. | 7. South Fork of Cumberland River, Kentucky. |
| 4. Clinch River, Tennessee. | |

EXAMINATIONS AND SURVEY.

- | | |
|---|--|
| 8. Little Pigeon River, Tennessee, from mouth to Sevierville. | 10. Obion River, Tennessee, from its mouth to the crossing of the Louisville and Memphis Railroad in Obion County. |
| 9. Harbor of Smithland, Kentucky. | |

ENGINEER OFFICE, U. S. ARMY,
Nashville, Tenn., July 7, 1891.

GENERAL: I have the honor to transmit herewith the annual reports upon the river improvements in my charge for the fiscal year ending June 30, 1891.

Very respectfully, your obedient servant,

J. W. BARLOW,
Lieutenant-Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

E E 1.

IMPROVEMENT OF TENNESSEE RIVER.

(Length, 650 miles.)

The exact point at which the Tennessee River has its beginning is still a matter of some uncertainty. The *Riviere des Cheraquis*, or Cheraque, of the early French explorers, and the Cherokee River as referred to in cessions to the English by the Indians in 1767, has been considered as being formed by the junction of what are now called the Little Tennessee and Holston rivers, near the town of Lenoirs, Tenn. Tennessee, the chief town of the Cherokee Indians, was situated near this point, and the fact that the river derives its present name from that town seems to add additional weight to the arguments of the geographers who have placed the headwaters of the river at this junction. In some of the older geographies the head of this river has been placed at the mouth of the Clinch and the Holston extended to that point.

The legislature of Tennessee in 1889 passed an act extending the name of the Tennessee River to the junction of the north and south forks of the Holston, at Kingsport, in Sullivan County, Tenn.

Congressional legislation, however, in several laws appropriating money for the improvement of the Upper Tennessee between Knoxville and Chattanooga, has given authority for extending the name at least to the former city, but as the junction of the Holston and French Broad rivers is but $4\frac{1}{2}$ miles above Knoxville, this point is now generally taken as the origin of the Tennessee River, and in the river and harbor act of 1890 this point appears to have been definitely fixed by the specific language of the act providing for a survey of the Tennessee River from Chattanooga to the junction of Holston and French Broad rivers.

As one of the largest of the forty-three or more tributaries of the Mississippi River, the Tennessee has always held an important place in the projects for the improvement of the navigable water ways of the country. The Muscle Shoals Canal having been opened to navigation in November, 1890, the Tennessee River is now navigable from its source to its mouth, a distance of 650 miles, during several months of each year, and as work is continued upon certain other less formidable obstructions the season of navigation will be correspondingly lengthened. The radical improvement of this river so as to make navigation continuous for boats of moderate draft is by no means an impossibility.

1. ABOVE CHATTANOOGA (194 MILES).

This section of the river is navigable during medium and high stages, which usually prevail through the winter and spring months, and occasionally at other seasons during the occurrence of so-called rain tides.

The navigation consists of steamboats carrying freight and passengers, flatboats bringing products from the upper tributaries, and rafts of logs and lumber, also brought from the tributaries, the latter constituting the major part of the commerce of this river.

In 1830, Col. S. H. Long, U. S. Topographical Engineer, made a careful examination of the Holston and Tennessee rivers between Kingsport, Tenn., and the Alabama State line. His report, published as Executive Document No. 167, House of Representatives, Forty-third Congress, second session, gives a detailed description of every obstruction to navigation at that time, and plans and estimates for their improve-

ment. In 1871 an examination was made between Knoxville and Chattanooga by Capt. L. Cooper Overman, Corps of Engineers, under the direction of Maj. Walter McFarland, Corps of Engineers. (See Reports of the Chief of Engineers, 1871, pp. 502 to 507, and 1872, pp. 488 to 494.) The obstructions to navigation, as described in these reports, were "low-water obstructions," consisting of bars, either rock or gravel, extending across the river, with a length varying from 60 feet to 2 miles, the depth of water over these bars varying from 10 to 30 inches at extreme low water, and the current varying from $2\frac{1}{2}$ to 6 miles per hour.

The bed and banks of the river are of such character as to make any improvements practically permanent, with the exception of the removal, from time to time, of such drift or snags as may be brought down by the annual floods.

In 1832 the State of Tennessee undertook the improvement of certain points above Chattanooga by removal of rock and construction of wing dams.

In 1850 Congress appropriated \$50,000 for the improvement of this portion of the river, and the money appropriated was expended under the direction of Col. J. McClellan, topographical engineer, U. S. Army. Some of the dams built under this appropriation are still in existence, though generally covered up by the more extensive work of recent improvements.

The present project of improvement, based upon the examination of 1871, provides for deepening the channel at the worst obstructions by blasting or by scouring bars by the aid of wing dams, and the removal of such snags and drift as may prove dangerous to navigation; this is to be done to an extent that will secure a channel 3 feet in depth at average low water. The estimate of 1871 was increased in 1874, 1877, and again in 1884, for the reasons stated in the reports of those years. Fifteen appropriations from July 11, 1870, to September 19, 1890, have been made by Congress for this work, aggregating the sum of \$271,000.

The amount expended, including outstanding indebtedness, to June 30, 1890, was \$237,252.80.

Operations have been confined to the improvement of twenty-nine of the forty-three obstructions as enumerated by Colonel Long, and have resulted in giving an improved channel at these points and a lengthened season of navigation. This improvement has been of special advantage to rafts and flatboats, which compose the major part of the commerce of the Upper Tennessee. As a matter of convenience and economy operations are carried on in connection with the rivers tributary to this section of the Tennessee.

At the beginning of the fiscal year work was in progress at White Creek Shoals, and continued during the months of July, August, and September, work done at that point being 630 cubic yards of earth, etc., stripped from quarry, 2,187 cubic yards stone quarried for dams, and 2,835 cubic yards dam built.

In previous years a dam 650 feet long had been built from the lower end of White Creek Island to create a scour through the sand and gravel bar which was originally a serious obstruction to the navigation of the river at this place. Its effect was to deepen the water opposite the dam and to cause the deposit of the material in the form of a half-moon bar in the channel just below the end of the dam, the only available passage for boats being a cross channel between the bar and the end of the dam.

In 1889 this dam was extended 175 feet, the result being that the cross channel around end of dam was removed a short distance lower

down; the obstructing bar reforming about 300 feet down stream, the obstacles to navigation remained about the same as before. In 1890 the dam was further extended about 300 feet, and a spur 130 feet long built out into the channel to create a scour which would remove the obstruction, the object being to scour away the bar and deposit the material in prolongation of the longitudinal dam. The bar reformed, but to a less extent, about 600 feet below the spur dam. The longitudinal dam was again extended over the shoal 560 feet farther, and a second spur 215 feet long was built on the new shoal. The result of this last work has been to cause the removal of the obstruction to the deep water below the last spur, and it is believed that it is not likely to reform for many years in the navigable channel. This improvement is a very interesting example of the combined effect of a longitudinal dam with short spurs in removing gravel or sand bars.

During October, November, and December continued work at Soddy Shoals and vicinity, and near the Cincinnati Southern Railroad Bridge. The work done in the channel consisted of the removal of a sunken barge, 40 cubic yards of loose rock, and 24 snags; 258 overhanging trees were cut down and removed.

Operations were suspended on account of high water, but were resumed at Soddy Shoals in June, 1891, and preparations are now in progress for drilling and blasting upon this troublesome reef, under the supervision of Assistant Engineer C. A. Locke.

The steam drilling scow, which has been provided by adapting the old hull of the steamer *Weitzel* to this purpose, will be employed upon this work. The United States steamer *Weitzel* was thoroughly rebuilt at Chattanooga for use on the Cumberland River.

In addition to the proposed work required at Soddy Shoals, improvements are needed at Caney Shoals, near Kingston, and at Seven Island Shoals, or Farmers Dam, as this place is now called. The character of the work is the same at both places, and will consist in the construction of a wing dam located below each shoal to lengthen the fall and decrease the velocity of the current.

The *Weitzel* having been transferred to the Cumberland River for service upon that stream, the steamer *Dover*—renamed and duly recorded as the *McPherson*—was purchased for use upon the Upper Tennessee and its tributary waters. The *McPherson* reached Chattanooga early in May and was at once engaged in moving to the mouth of the French Broad River the survey party organized at Chattanooga for the survey of the Tennessee River from Chattanooga to the junction of the Holston and French Broad Rivers, as provided by act of September 19, 1890. This survey began at the confluent waters of the Holston and French Broad Rivers, and has made good progress, about 35 miles of river from the initial point having been surveyed.

As required by the act, a careful and comprehensive survey, about 194 miles of river, is being made by First Lieut. John Biddle, Corps of Engineers, in local charge of the work. The discharge of the river is being ascertained, current observations taken, and substantial benchmarks established.

The total amount expended during the fiscal year ending June 30, 1891, was \$17,210.77, as follows:

General improvement	\$12,391.37
Survey from Chattanooga to junction of Holston and French Broad Rivers.	4,819.40

The original estimate of cost of improving Tennessee River above Chattanooga, under the existing project, was \$175,000; increased in 1877 to \$225,000, and again in 1884 increased to \$300,000. The appro-

priation of \$30,000 by act of September 19, 1890, nearly exhausts the above-named estimate. Pending the submission of the report, with its accompanying plans and estimates, of the survey of the Tennessee River above Chattanooga, Tenn., now in progress, for approval and subsequent adoption as the basis for a new project, it is necessary to increase the estimate under the existing project, and the sum of \$40,000 is added thereto.

The estimate, as modified in 1884, for improving Tennessee River above Chattanooga is.....	\$300,000.00
Increased in 1891.....	40,000.00
	<hr/> 340,000.00
Amount appropriated.....	271,000.00
Amount expended.....	253,891.33

Money statement.

July 1, 1890, balance unexpended.....	\$4,319.44
Amount appropriated by act approved September 19, 1890.....	30,000.00
	<hr/> 34,319.44
June 30, 1891, amount expended during fiscal year.....	14,800.74
	<hr/> 19,518.70
July 1, 1891, balance unexpended.....	19,518.70
July 1, 1891, outstanding liabilities.....	2,410.03
	<hr/> 17,108.67
{ Amount (estimated) required for completion of existing project.....	69,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893.....	69,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

2. BELOW BEE TREE SHOALS (225 MILES).

The available information pertaining to the section of the river below Bee Tree Shoals is very meager. In report on line of water communication between the Mississippi River and the Atlantic (Report of Chief of Engineers, 1872, page 513), Maj. Walter McFarland, Corps of Engineers, states:

Descending the river, we find that improvements of some kind or other—removing rock or gravel or constructing wing dams in order to straighten or widen the channels or to give them sufficient depth—will be required at the following points viz: Bear Creek Shoals, Indian Creek, Big Bend Shoals, Diamond Island, Wolf Island, Chalk Bluff, Beech Creek Shoals, Buffalo Shoals, Armstrongs Towhead Bridge at Johnsonville, Duck River Shoals and Suck, Turkey Island Shoals, White Oak Island, Harriican Island, Leatherwood Shoals, Sandys Island, Panther Creek Island, McCulloughs Bar, Blood River Island, Pentecost Towhead, Widow Reynolds Bar, Grubbs Towhead, Little Chain, and Grand Chain.

In 1875 an examination was made of Duck River Shoals. In May, 1889, an examination was made of the river immediately below the Johnsonville Bridge.

In 1878 some work was done at Duck River Shoals. This shoal is a gravel bar and is subject to considerable change from the action of the current; in 1882 the river men reported that it was much less deserving of attention than other obstructions below Florence. In 1881 and 1882 a small force with a snag boat was employed a short time in each year removing from the channel a large number of snags and overhanging trees. Assistant Engineer J. H. Mayhew, who was in charge of snag-

2258 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of proposals for the construction of a pile and stone dike at Livingston Point, Kentucky, at the mouth of Tennessee River.

[Opened March 11, 1891, by Lieut. Col. J. W. Barlow, Corps of Engineers.]

No.	Name and residence of bidder.	Piles (535).		Timber.						Iron rods (9,100 pounds).	
		Each.	Total cost.	12 by 12 inches, 16 feet long, 14,400 feet B. M., per 1,000 feet B. M.	12 by 12 inches, 40 feet long, 19,800 feet B. M., per 1,000 feet B. M.	Oak: 5 by 10 inches, 7,000 feet B. M., per 1,000 feet B. M.	Total cost.	Per pound.	Total cost.	Per pound.	Total cost.
1	William Kirk, Madison, Ind.	\$3.00	\$1,605.00	\$25	\$25	\$25	\$1,027.00	\$0.06	\$546		
2	Thomas J. Hardin, Monterey, Ky.	4.50	2,407.50	25	45	21	1,413.60	.04	361		
3	Fred Hartweg, Cincinnati, Ohio	5.00	2,675.00	25	40	22	1,301.20	.04	364		
4	Henry C. Jones, Madison, Ind.	7.00	3,745.00	27	27	20	1,060.16	.07	637		

No.	Name and residence of bidder.	Spikes (6,700 pounds).		Stone.			Brush (2,000 cords).		Grand Total cost.
		Per pound.	Total cost.	For dike, 2,000 cubic yards, per cubic yard.	For riprap, 5,000 cubic yards, per cubic yard.	Total cost.	Per cord.	Total cost.	
1	William Kirk, Madison, Ind.	\$0.06	\$402	\$1.25	\$1.25	\$9,375	\$0.80	\$1,600	\$14,555.00
2	Thomas J. Hardin, Monterey, Ky.	.04	268	.95	1.50	10,150	1.50	3,000	17,603.10
3	Fred Hartweg, Cincinnati, Ohio	.04	268	1.15	1.65	11,375	.89	1,780	17,763.20
4	Henry C. Jones, Madison, Ind.	.07	469	.95	1.80	11,800	.85	1,700	19,411.16

Contract entered into with William Kirk March 30, 1891.

COMMERCIAL STATISTICS.

Tennessee River above Chattanooga, Tenn., from July, 1, 1890, to June 30, 1891.

Articles.	Tons.	Articles.	Tons.	Articles.	Tons.
Corn	4,385	Hogs	65	Eggs	17
Peas	127	Cattle	150	Chickens (coops)	8
Wheat	158	Sheep	4	Merchandise	1,470
Oats	5	Railroad iron	225	Tanbark	298
Hay	1,079	Coal	15,396	Rock	67
Shucks	98	Iron ore	81,436	Shingles	1
Straw	111	Sand	7,056	Wood	73
Lumber	683	Cross ties	127		
Logs	56,000	Flour	100		

Number of passengers, 2,716.

List of steamboats (stern-wheel) plying on Tennessee River above Chattanooga.

Names.	Length.	Breadth.	Depth.	Ton- nage.	Names.	Length.	Breadth.	Depth.	Ton- nage.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>			<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	
Citico	75	13	3	31.30	Rockwood.....	130	25	4	226.26
Dayton	142	24.07	3.08	357.49	Tallassee.....	60	12	2	44.32
J. R. Hughes.....	98	17	3	160.36	W. L. Dugger.....	130	27	3.08	224.13
J. W. Bussell.....	76	9	2.08	49.60	W. L. Norton.....	68	12	3	63.01
Myra	100	18	3.05	148.42	Walter R. Love.....	112	18	3.05	173.53
M. H. Clift.....	105	18	3.05	164	Ella Durham.....	38	7	3.07	22.27
May Tillman.....	79	15	3	32.72	J. C. Warner.....	142	31.06	4.06	347.43
P. Dickenson.....	122	28	4	205.97	Wyeth City.....	120	21.50	4.80	138.96
Pin Hook.....	94	18	3	160.36					

Tennessee River below Chattanooga, Tennessee, Alabama, and Kentucky, below Bee Tree Shoals, Riverton, Ala., from July 1, 1890, to June 30, 1891.

Articles.	Tons.	Articles.	Tons.	Articles.	Tons.
Railroad ties	166,963	Iron	9,233	Logs	70,575
Bricks	427	Lumber	24,026	Tanbark	260
Live stock	320	Salt	177	Spokes	5
Cotton	1,721	Tobacco.....	418	Coal	350
Flour	3,687	Staves	3,117	Stone	15,031
Grain	4,566	Peanuts.....	2,596	Wood	120
Hay.....	112	Cotton seed	500	General merchandise..	10,196

Number of passengers; 7,522.

List of steamboats plying on Tennessee River below Chattanooga, Tennessee, Alabama, and Kentucky, below Bee Tree Shoals, Riverton, Ala.

Name.	Length.	Breadth.	Depth.	Tonnage.	Draft.	
					Light.	Loaded.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>
City of Paducah.....	190	32	6	700		
City of Savannah.....	186	31	5	335.55	2.5	5
Charley McDonald.....	150	30	4.5	259.52	4	5
Excel	122	21.5	3.5	118.92	3	4
Jennie Campbell.....	147	28	4.5	225.56	3	5
Gus Genin.....	120	20	4.5	130.09	3	4.5
Louis Houck.....	210	37	6.5	913.27	4.5	6.5
George Lyale.....	173	33	6	426.74	4.5	6
Eagle	155	24	5	231.90	3.5	5
Josie	143	28	5	237.51	2.5	5
Ironsides (towboat).....	154	30	6	282	3.5	6
Iron Age (towboat).....	176	38	6	385	4	6
Hiawatha.....	141	30	5.5	245	1.8	4
W. F. Nisbet.....	200	35	5.5	576.96	3.5	6.5
City of Sheffield.....	180	35	5	329.74	2.5	7
Albert F. Willis.....	152	26	4	132.99	2.5	3.5
Clyde	206	40	5.06	450		7
A. J. Duncan.....				300	2	
C. Smith.....				250	1.8	4.6
Iron Duke.....				421	4.6	6.6

E E 2.

IMPROVEMENT OF HIAWASSEE RIVER, TENNESSEE.

Rising in the Blue Ridge Mountains, in western North Carolina and northern Georgia, the Hiawassee flows in a west-northwesterly direction and enters the Tennessee River about 38 miles above Chattanooga and 151 miles below Knoxville. After breaking through the Smoky Mountain range and receiving the waters of the Ocoee, near Columbus, the Hiawassee becomes a stream of good capacity for navigation.

As early as 1830 the State of Tennessee made some minor improvements, but the work was only of temporary advantage. The act of Congress of June 23, 1874, authorized an examination of this river. The examination was made in September, 1874, under the direction of Maj. Walter McFarland, Corps of Engineers. The principal obstructions were found to be rock reefs, gravel bars, snags, and overhanging trees. (See Report of Chief of Engineers, 1875, pages 809 to 813.)

The project for the improvement was based on this examination, and consisted in narrowing the water way at the shoal places by wing dams, and excavating rock reefs and gravel bars so as to secure a navigable channel 40 feet wide and 2 feet deep at ordinary low water as high up as Savannah Ford, about 43 miles from the mouth of the river.

The original estimate of \$20,000 was increased from 1878 to 1885 to \$36,500, which amount has been fully covered by the following appropriations, viz:

August 1, 1876.....	\$10,000
June 12, 1878.....	10,000
March 3, 1879.....	3,000
June 14, 1880.....	3,000
March 3, 1881.....	1,500
August 2, 1882.....	1,500
July 5, 1884.....	2,500
August 5, 1886.....	2,500
August 11, 1888.....	1,000
September 19, 1890.....	1,500
Total.....	36,500

The amount expended to June 30, 1890, including outstanding liabilities, was \$34,971.95.

The funds appropriated have not been sufficient to secure a radical improvement of the river. The work done during the past 11 years has resulted in a partial improvement of the lower river, securing an increased depth of channel and the removal of surface obstructions and overhanging trees.

The work was done at different times at the following obstructions: Matthews Shoals, McElrath Shoals, Sivils Shoals, Magills Island, Blackbird Shoals, Graves Ferry and Shoals, Canefield Reef, Lasters Creek Shoals, Brindley Shoals, Denton Island Shoals, Boyd Shoals, Horseford Shoals, and Gamble Shoals. The Hiawassee is now navigable for steamboats from its mouth to Charleston, 21 miles, during the boating season on the Upper Tennessee River. Above Charleston to Savannah Ford flatboats are used for transportation.

No funds were available for this work at the beginning of the present fiscal year, and when the appropriations of September 19, 1890, became available for expenditure it was too late in the season to commence active operations. No expenditures were made during the fiscal year ending June 30, 1891.

The amount now available will be expended in clearing the channel of surface obstructions and repairing existing dams, principally at Matthews Shoals.

As soon as practicable, and as a matter of economy, the small amount of work to be done will be carried on in connection with the work on the upper Tennessee River.

In common with other mountain streams, the Hiawassee River requires that the channel be kept clear of the snags, logs, etc., brought down by the annual floods, and provision should be made for such work, so that the advantages resulting from previous expenditures be maintained; but it is not deemed advisable to again increase the estimate

under the existing project, but rather to recommend that if this stream is to be radically improved provision be made for a survey sufficiently in detail whereon to base plans and estimates, and that a new project be prepared and submitted.

Estimate of cost of improving Hiawassee River, Tennessee	\$36,500.00
Amount appropriated	36,500.00
Amount expended, including outstanding indebtedness	34,951.53

Money statement.

July 1, 1890, balance unexpended	\$86.51
Amount appropriated by act approved September 19, 1890	1,500.00
July 1, 1891, balance unexpended	1,586.51
July 1, 1891, outstanding liabilities	38.04
July 1, 1891, balance available	1,548.47

COMMERCIAL STATISTICS.

Hiawassee River, Tennessee, from July 1, 1890, to June 30, 1891.

Articles.	Tons.	Articles.	Tons.	Articles.	Tons.
Corn	1,815	Meal	5	Cattle	103
Guano	329	Hay	216	Cross-ties	30
Cotton seed	13	Shucks	54	Flour	25
Peas	116	Cotton	50	Eggs	5
Wheat	97	Straw	57	Coops chickens	4
Onions	6	Lumber	310	Merchandise	672
Oats	3	Hogs	46		

Number of passengers, 2,252.

The steamboat *Wyeth City* (length, 120 feet; breadth, 21.5 feet; depth, 4 feet, and tonnage, 138.96 tons) made eighty-one trips between Chattanooga and Charleston during the fiscal year.

E E 3.

IMPROVEMENT OF FRENCH BROAD RIVER, TENNESSEE.

The French Broad River—the Tah-kee-ostee or Racing Water of the Cherokees—is one of the largest tributaries of the Tennessee. This stream has its source in North Carolina on the western slope of the Blue Ridge, enters the State of Tennessee at Paint Rock, and after a course of 121 miles, draining what has been called the “Land of the Sky,” unites with the Holston River $4\frac{1}{2}$ miles above Knoxville, thus forming the Tennessee River.

An examination was made of the French Broad in Tennessee under authority of an act of Congress approved July 11, 1870, and the report upon it is to be found in the Report of the Chief of Engineers for 1871, pages 491 to 494. A reëxamination in Tennessee was ordered by Congress in 1875, “from the Holston to Leadvale.” The estimate made in 1871 was resubmitted with the report of 1876.

Below Leadvale—mouth of the Nolichucky River, a distance of 90 miles—the river is impeded by the surface obstructions usually found

in mountain streams. The fall in this section is about 1 foot per mile, and the channel could easily be improved. From the junction of the Nolichucky to the Tennessee State line, 31 miles, the French Broad is not susceptible of improvement except by slackwater navigation, the fall being 7 feet per mile.

The present plan of improvement from its mouth to Leadvale, about 90 miles, consists in removing obstructions from the channel, cutting down overhanging trees, and building wing-dams where necessary so as to permit the passage of boats drawing $2\frac{1}{2}$ feet of water during the ordinary low-water season. This part of the river is exceptionally beautiful, broad, and adapted to navigation, especially below Dandridge, a distance of about 50 miles. Under this plan of improvement operations have been carried on at the most important obstructions.

The following appropriations have been made for this work:

Act of—

June 14, 1880	\$10,000
March 3, 1881	3,500
August 2, 1882	5,000
July 5, 1884	3,500
August 5, 1886	6,000
August 11, 1888	10,000
September 19, 1890	10,000
Aggregate	48,000

The amount expended, including outstanding indebtedness, to June 30, 1890, was \$37,435.56.

The improvements so far made at the principal obstructions, by deepening the channel, etc., though limited and incomplete, appear to give satisfaction to the raftsmen and boatmen navigating its waters. These improvements are as follows:

Location.	Work done.	Distance below Dandridge.
Fain Island	5 dams built; channel excavation	1 mile.
Denton Shoals	2 dams built	5 $\frac{1}{2}$ miles.
Evans Island	6 dams built	10 miles.
Seffl Shoals	2 dams built	12 miles.
Bryant Shoal	do	15 miles.
Hanging Rock	Old fish dam removed; channel excavation	18 miles.
Seven Islands, including Wesley and Tuckahoe chutes	Part of old dam removed; 2 dams built	30 miles.
Cement or Sewee Shoals	Old dam modified; channel excavation; bank revetted; 8 new dams built	
Chapbella Shoals	3 dams built	32 miles.
Jumping Moses Shoals	1 dam built	34 miles.
	5 spurs and 1 submerged dam built	40 miles.

The improvements at Seven Islands Shoals were made during 1889 and 1890, and are the most important done on the French Broad in several years, having resulted in making this obstruction navigable for steamers at stages of the river when previously upstream navigation was impracticable. The dams at foot of shoal have had a marked effect in reducing the current at this place and also in deepening the water in Tuckahoe Chute above. At the Wesley Chute, the change in channel produced by the removal of a part of the old dams and the construction of a short cross-dam so as to throw the channel along the north bank has resulted in a material reduction in the velocity of the current and removed the danger of striking one of the dams, which previously existed. It is proposed to make a similar change at Tuckahoe Chute, so as to somewhat lengthen the channel and lessen the abruptness of the curve opposite Round Island.

At Bryant Shoal the modification and enlargement of the old wing-dam and the removal of bowlders from the channel has greatly improved navigation. Work is now in progress and will result in the construction of a second dam placed immediately below the shoal to deepen the water on the shoal and reduce the velocity of the current by lengthening the slope. A "cut off" dam at head of island may also be built to improve the approach to Little Pigeon River, if deemed advisable.

Great benefit has resulted from the improvements made at Jumping Moses Shoal, near mouth of the river, its dangerous condition having been greatly modified.

The shoals below Dandridge, which are now considered as most pressing in need of treatment, are the Tuckahoe Chute, Seven Islands; Bryants Shoal, the Gallops, and Hanging Rock. Instrumental examinations will be made at the last two shoals mentioned, with a view of determining the best methods to be employed in their improvement, and it is hoped that with the funds available some work can be done upon them.

During the fiscal year work was resumed at Bryants Shoal, and is now in progress, and for this purpose the fleet of barges and quarter boats was towed from its moorings on the Tennessee River by the U. S. steamer *McPherson*, purchased in March for use upon the Upper Tennessee River and its tributaries, and paid for in part from the appropriation for improving the French Broad River.

The work done at Bryants Shoals was as follows:

Loose rock removed from channel.....	cubic yards..	195
Quarry stripped	do	435
Stone quarried for dams.....	do	495
Riprap dam built.....	do	195

The amount expended during the fiscal year, including outstanding indebtedness, was \$4,027.05.

The improvement of the French Broad River, Tennessee, is of vital importance to the many interests of the inhabitants along its banks, as is shown by the number of passengers reported by the *Lucille Borden*. Commerce on this stream has already reached considerable proportions.

The completion of the existing project of improvement will open a river highway for the transportation of the mineral wealth of the mountains, and will materially aid in the development of the mines in its locality. Marble, sand, logs, lumber, forage, grain, live stock, wood, and general merchandise make up the commerce of this stream. Capt. J. E. Newman, of the steamer *Lucille Borden* plying upon this river, reports that the French Broad River from Knoxville to Catlettsburg, 40 miles, was navigable for his boat (which has a draft of 30.8 inches when loaded) during the entire year, excepting 15 days in July and 7 days in December. From Catlettsburg to Dandridge, 30 miles, it was navigable since January last, but not much prior to that month.

In reply to the inquiry, "What benefits have been derived from the work done?" Captain Newman writes:

"Before there was any work done on the river by the Government we could not run over 6 months in the year, but, as shown above, with anything like ordinary water we can run all the time now. But there remains much yet to be done, as it is only small steamers that can ply on the river at all, while with some more work we could ply with much larger steamers than are run now. The work at Seven Islands, although not completed, has done much good. Before any work was done here by the United States it usually took a boat from one-half to 1½ days to go through, where now we can go through in 45 minutes."

Estimate of cost of improving French Broad River, Tennessee, from mouth to Leadvale.....	\$150,000.00
Amount appropriated	48,000.00
Amount expended, including outstanding indebtedness.....	41,301.11

Money statement.

July 1, 1890, balance unexpended.....	\$725.94
Amount appropriated by act approved September 19, 1890.....	10,000.00
	<hr/> 10,725.94
June 30, 1891, amount expended during fiscal year.....	2,580.48
	<hr/> 8,145.46
July 1, 1891, balance unexpended.....	8,145.46
July 1, 1891, outstanding liabilities.....	1,446.57
	<hr/> 6,698.89
July 1, 1891, balance available.....	6,698.89
	<hr/>
{ Amount (estimated) required for completion of existing project.....	102,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893.....	30,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

French Broad River, Tennessee, from July 1, 1890, to June 30, 1891.

Articles.	Tons.	Articles.	Tons.	Articles.	Tons.
Grain.....	5,635	Plaster.....	95	Merchandise.....	2,248
Hay.....	1,505	Sand.....	80,390	Cattle.....	26
Lumber.....	5,480	Flour.....	1,042	Salt.....	180
Wood.....	246	Logs*.....	5,573	Tobacco.....	50
Hogs.....	233	Marble.....	6,036	Coal.....	50

* Logs estimated by the reporter at 200 feet B. M. per log, which was greatly below the usual estimate. Number of passengers, 2,680.

Stern-wheel steamer *Lucile Borden*, length 86 feet, breadth 14 feet, depth 2½ feet, tonnage 55 tons, made 96 trips from Catlettsburg to Knoxville and return.

E E 4.

IMPROVEMENT OF CLINCH RIVER, TENNESSEE.

The Clinch River rises in the Cumberland Mountains, in southwestern Virginia, and flows in a southwesterly direction, generally parallel to the Holston River, and empties into the Tennessee River at Kingston, Tenn., 110 miles above Chattanooga.

Between 1830 and 1845 work was done by the State of Tennessee, but it resulted in little or no advantage to navigation. The country drained by this river—about 1,436 square miles—is mountainous and has very meager transportation facilities other than are afforded by the Clinch River during rain tides.

Under authority of act of Congress approved March 3, 1875, examination of the river was made both in Virginia and Tennessee. (See Report of Chief of Engineers, 1876, pages 736 to 747.) An examination of the Clinch River from Nash's Ford, Virginia, to Haynes or Walker's Ferry, Tennessee, a distance of about 161 miles, was made in 1880. (See Report of Chief of Engineers, 1881, pages 1864 to 1867.) The obstructions in the channel were found to be rock reefs, sand and gravel bars, snags, and overhanging trees.

The examination made in 1875 forms the basis of the present project of improvement, which consists in removing ledges, rock points, gravel

bars, bowlders, snags, and overhanging trees, the obstructions common to all mountain streams tributary to the Tennessee River; building rip-rap dams so as to obtain at ordinary low water a channel depth of 2 feet from the mouth of the river to Clinton, about 70 miles, and 1½ feet from Clinton to Haynes or Walker's Ferry, about 75 miles. Above Walker's Ferry up to the Tennessee State line, 85 miles, the only improvement advisable is to reduce the ledges and remove loose rock, etc., sufficiently to assist flatboat navigation during "rain tides."

The following appropriations have been made for this improvement:

Act of—

June 14, 1880.....	\$10,000
March 3, 1881.....	3,000
August 2, 1882.....	3,000
July 5, 1884.....	5,000
August 5, 1886.....	5,000
August 11, 1888.....	5,000
September 19, 1890.....	4,000
Aggregate	35,000

The amount expended to June 30, 1890, including outstanding indebtedness, was \$31,000.

The results of the work done in previous years are that the reefs have been reduced, many snags and overhanging trees removed, and several strong, heavy wing and longitudinal dams built; thus securing a passable channel at stages of the water 2 or 3 feet lower than before the improvement was begun. Special advantages are gained at Blacks Shoals and Bletcher Shoals. The improvements have given very general satisfaction to the river men and the work done is practically permanent. Also, at Cloud Shoals 7 dams have been built, and a heavy dam at Hibb Shoals, which, with the rock excavation in channel, have materially lessened the dangers to navigation. Above Haynes improvements have been made at Hunters Shoals, Sycamore Shoals, and Hopson Shoals.

In April an instrumental examination of Llewellyn Shoals was made and a detailed map prepared upon which to locate the existing and proposed works. In May, the water having fallen, preparations for resuming work were begun, but owing to a subsequent rise nothing could be accomplished beyond repairing the plant, establishing a new camp, and general provisions for operations as soon as the water recedes. Forty cubic yards of stone were placed in dam at Llewellyn Shoals and 4 snags and overhanging trees removed.

Llewellyn Shoals are 3 miles above Clinton by land, and 10 miles by river. The shoal has a length of 1½ miles and the fall, 8.6 feet, is nearly uniform. The width of the river at this shoal is much greater than the average, being from 500 to 600 feet. The bed is composed of ridges of stratified rock with gravel and small bowlders between. On account of the wide channel and rapid current the water upon this shoal is but 12 to 18 inches in low stages, and the rough bottom renders it a very difficult obstruction.

The improvement now in progress of development consists in the removal of the most prominent projecting rocks in the channel, cutting off all secondary channels behind islands, and still further contracting the channel by means of a system of wing-dams at intervals along the banks. Considerable progress has been made as shown on map of this shoal; some channel work has been done, and two island dams finished, also two wing-dams and a third commenced.

It is proposed to complete wing dams No. 3, to add two more further down on the same side, and to continue the removal of the most ob-

structive rocks remaining in the channel, which will be all the work that is at present advisable.

Youngs Island Shoal at foot of Eagle Bend, 1 mile above Clinton, is an obstruction reported as very objectionable to the logging interests. An examination at this point will be made, and if found advisable to improve it under the present project, work will be done there as soon as practicable.

The section of river below Clinton, a distance of about 70 miles, is practicable for steamboat navigation during the higher stages of the river, and to increase the length of the season of navigation the present project contemplates the construction of wing-dams and other channel work at the most troublesome obstructions. As but little has heretofore been done on this part of the river, and as the work above has been carried as far as necessary for the present, it is proposed to take up the project of improvement below Clinton, applying to that object the amount herein asked for, \$15,000, and as much of subsequent appropriations as may be necessary to complete the necessary improvements.

Since the construction of the Knoxville, Cumberland Gap and Louisville Railway, completed August 23, 1889, which crosses the river some distance above Haynes, the character of the commerce has changed to a considerable extent. The grain which had previously been carried down this river in flatboats on "rain-tides" now seeks a market by means of the railroad. The principal navigation at present consists of logs and zinc ore; immense tracts of uncut timber still remain in the country adjacent to this stream, and will for a long time to come require its channel as a means of transportation. The products of the zinc mines are still brought down in flatboats to the reducing works at Clinton. These ore deposits are reported as being very extensive and practically dependent upon the river for transportation.

The amount expended during the fiscal year, including outstanding indebtedness, was \$978.14.

Estimate for improving Clinch River, Tennessee, as modified in 1885.....	\$50,000.00
Amount appropriated	35,000.00
Amount expended, including outstanding indebtedness.....	31,964.09

Money statement.

July 1, 1890, balance unexpended.....	\$14.05
Amount appropriated by act approved September 19, 1890	4,000.00
	<hr/>
	4,014.05
June 30, 1891, amount expended during fiscal year	503.35
	<hr/>
July 1, 1891, balance unexpended	3,510.70
July 1, 1891, outstanding liabilities	474.79
	<hr/>
July 1, 1891, balance available.....	3,035.91
	<hr/>
{ Amount (estimated) required for completion of existing project	15,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	15,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Clinch River, Tennessee, from July 1, 1890, to June 30, 1891.

	Tons.
Logs.....	631,786
Zinc	700

E E 5.

IMPROVEMENT OF CUMBERLAND RIVER, TENNESSEE AND KENTUCKY.

The Cumberland River, having its source in eastern Kentucky on the western slope of the Cumberland Mountains, flows through eastern Kentucky, middle Tennessee, and western Kentucky in a devious and eccentric course to its junction with the Ohio River at Smithland, Ky. From Point Burnside, Ky.—the head of steamboat navigation—to Smithland, Ky., is 205 miles on an air line, while by way of the Cumberland River the distance is 518 miles; 203 miles being in the State of Kentucky and 315 miles in the State of Tennessee.

From 1830 to 1840 the legislatures of Tennessee and Kentucky made several appropriations for the improvement of the navigation of the Cumberland River. Little benefit to the general condition of the river seems to have been accomplished. "The Cumberland Navigation Company" was incorporated by the State of Tennessee in 1846 for improving the "navigation of the Cumberland River below the town of Nashville" by means of a system of locks and dams, but nothing tangible was done to carry out the proposed improvement.

Between 1832 and 1838 Congress appropriated \$155,000, which was expended in carrying out the project based on the survey of Capt. Howard Stanbury, authorized by act of Congress.

From 1838 to 1871 no appropriations were made by Congress for the Cumberland River.

By act of July 11, 1870, Congress authorized an examination and survey of the Cumberland River. In reports of the Chief of Engineers, 1871, pages 468 to 485, and 1872, pages 463 to 472, may be found the reports of Maj. Godfrey Weitzel, Corps of Engineers, U. S. Army, giving description of the Cumberland River, from the Great Falls of the Cumberland—the head of navigation—to the mouth of the river at Smithland, Ky. This survey furnished the basis of the project under which the work below Nashville has been done, the original estimates having been increased in 1884 and 1888. From Nashville to Smiths Shoals the work was carried on under the project of 1871 until 1884. A survey of the river from the head of Smiths Shoals was made in 1882 and 1883. (See Report of the Chief of Engineers, 1884, pages 1663 to 1675.) On this survey was based the present project of improvement by locks and dams of the Cumberland River above Nashville. A survey of Smiths Shoals made in 1874 (see Report of the Chief of Engineers, 1875, pages 795 to 800) is the basis of the project under which work has been done at that locality. A survey of the Falls of the Cumberland River was made in 1878. (See Report of the Chief of Engineers, 1879, pages 1279 to 1282.) An examination above the falls was made in 1880. (See Report of the Chief of Engineers, 1881, pages 1854 to 1859.)

Under provisions of act of August 11, 1888, a detailed instrumental survey was made of the "Lower Cumberland River from Nashville to its mouth, to ascertain if necessary to establish locks and dams." (See Report of the Chief of Engineers, 1890, pages 2151 to 2161.)

The fifteen appropriations made by Congress from 1871 to 1890 amount to \$1,176,000.

The obstructions are of a uniform character, consisting of rock ledges, gravel and sand bars, bowlders, snags, overhanging trees, and other surface obstructions.

The river is divided into two divisions.

1. BELOW NASHVILLE (191 MILES).

The Cumberland River is navigable below Nashville for all steamboats plying on it for 6 months in each year; for boats not drawing over 3 feet, from 6 to 8 months, and for boats drawing 16 inches or less, for the whole year. In seasons of unusually low water the mouth of the river, at Smithland, Ky., is seriously obstructed by the formation of sand bars. Up to this time the work below Nashville has been carried on under the project of 1872, which, to quote from the original report, is—

To excavate the bars and rock ledges to get an additional depth of water, to contract the water way in places to get the requisite depth; to remove snags and bowlders from the main channel, and to restrain tributary streams in well-determined channels at their junction with the river.

Up to June 30, 1890, \$265,000 had been appropriated to this section, \$262,061.16 of which had been expended, including outstanding indebtedness, which has resulted in giving an increased depth at low water and a lengthened season of navigation, together with greater immunity from the perils of navigation at the most dangerous obstructions.

In July a force was employed at Lower Gatlin Shoals in reducing the bar in the channel by the removal of 40 cubic yards of sand and gravel, and in modifying the longitudinal dam by the removal of 748 cubic yards of rock, and 923 cubic yards of a new spur riprap dam was built, to secure greater depth over the bar. The available funds being nearly exhausted, active operations were suspended and engineer property placed in charge of watchman at Shelleys Island.

The United States snag boat *Weitzel*, having been rebuilt with an enlarged hull and otherwise thoroughly refitted at the expense of and for use upon the Cumberland River, while en route from the Tennessee River to the Cumberland River above Nashville removed 22 snags and 549 overhanging trees between Smithland and Nashville. This snagging was done when the river was at too high a stage for the most effective work; therefore during the next low-water season—probably July and August—the *Weitzel* will return and thoroughly clear the channel of surface obstructions below Nashville.

The Board of Engineer Officers (see Chief of Engineers' Report, 1888, pages 1626 to 1632) recommended the construction of a dike at Smithland, Ky., at an estimated cost of \$129,600, so as to increase the depth of water on the shoals at the junction of the Cumberland River with the Ohio River. The river and harbor act approved September 19, 1890, provides that \$30,000 of the appropriation for improving the Cumberland River below Nashville shall be expended in improving the mouth of the river. Advertisements were issued, and proposals for building a portion of the dike were opened on 27th February, 1891, and contract was entered into on 12th March, 1891, with Frederick Hartweg, of Cincinnati, Ohio. As soon as the stage of water permits work will commence on the dike.

The amount expended during the fiscal year, including outstanding indebtedness, was \$5,498.65. For "General improvement," \$5,366.38; for "At mouth of river," \$132.27.

Active operations will be resumed as soon as the stage of water permits, preparations to that end being in progress at the close of the fiscal year.

The following work is projected:

At *Lower Nashville Island*.—To remove from channel old hull of sunken steamer *Hillman*.

At *Sycamore Shoals*.—To remove gravel bar from channel.

At *Palmyra Bar*.—To improve channel by modifying the present dam and dredging through sand and gravel bar.

At *Shelleys Island*.—To remove snags and gravel deposit in channel.

At *Big Horse Ford*.—To remove boulders and reduce gravel bar in channel; to take out loose rock at head of shoals.

At *Camp Rowdy*.—Snags and gravel bar should be removed and the banks cleared of overhanging trees. A substantial wing dam is also needed at this place in accordance with the prosecution of the present plan of improvement.

The instrumental survey made in 1889 shows the estimated cost of radically improving the Cumberland River below Nashville to be \$1,964,500. In my report of December 21, 1889, upon this survey, after referring to the most serious obstructions, is the following statement explanatory of past work and suggestive of future operations:

Efforts have hitherto been made to reduce the fall over these several shoals and thus lengthen the season of navigation by the usual methods of wing dams and channel excavation. This class of work has been carried on as far as seems expedient to continue it, and the results, although valuable, do not satisfy the interests of navigation, a more radical improvement, in keeping with that in progress on the river above Nashville, being demanded. * * * From an engineering point of view this survey seems to thoroughly establish the feasibility of the improvement of this river by locks and dams as far down as Big Eddy Shoals, and as a continuance of the method now in progress above Nashville it would appear to be worthy of adoption, similar commercial reasons applying to both sections.

This project, which provides for the construction of locks and dams below Nashville, thus constituting an extension of the lock and dam system above Nashville, together with certain channel work and improvement at the mouth of the river, estimated to cost \$1,964,500, has been submitted to Congress.

Provision has been made to begin the work at the mouth of the river, a part of this project, and the estimate of its cost was added in 1888 to the estimates as part of the existing project. No special action having been taken upon the project for the locks and dams, the estimates therefor have not been added. If, however, the projected canalization is or may be approved by Congress the sum of \$300,000 can be profitably expended during the next fiscal year in constructing the first lock of the series at Harpeth Shoals, one of the worst obstructions below Nashville. Work has been carried on at this obstruction at various times since 1870, and it is still a formidable obstacle to navigation, but its much-needed radical improvement would be effected by the construction of the lock and dam as projected.

The commerce of the Lower Cumberland consists principally of grain, tobacco, logs, lumber, wood, general merchandise, and passengers. This river is one of the principal tributaries of the Mississippi system, and supplies in many cases, both above and below Nashville, the only means of transit between the towns and villages lying along its course.

The funds now available and the amount herein asked for, \$193,000, can be profitably expended under the existing project as follows:

To complete the dike and bank protection at mouth of river, balance of estimate	\$99,600.00
(Report of Chief of Engineers, 1880, page 1628.)	
To continue work of removing surface obstructions and improving channel by excavation and construction of wing-dams, etc	93,400.00
	<hr/> 193,000.00
The original cost of improving Cumberland River below Nashville, as modified in 1884 and 1888	498,000.00
Amount appropriated	305,000.00
Amount expended, including outstanding indebtedness and amount covered by contract	281,236.10

Money statement.

July 1, 1890, balance unexpended	\$3,241.55
Amount appropriated by act approved September 19, 1890.....	40,000.00
	<hr/> 43,241.55
June 30, 1891, amount expended during fiscal year.....	4,500.56
July 1, 1891, balance unexpended.....	38,740.99
July 1, 1891, outstanding liabilities.....	\$998.09
July 1, 1891, amount covered by uncompleted contracts.....	16,979.00
	<hr/> 17,977.09
July 1, 1891, balance available	20,763.90
<hr/>	
{ Amount (estimated) required for completion of existing project.....	193,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	193,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

2. ABOVE NASHVILLE (337 MILES)—FROM NASHVILLE TO HEAD OF SMITHS SHOALS.

For steamboats drawing not more than 3 feet the Cumberland River is navigable 4 to 6 months in each year to Point Burnside, Ky., and for boats of greater draft from 2 to 3 months. To Carthage (mouth of Cahey Fork), 118 miles, the river is navigable for steamboats of 2½ feet draft from 6 to 8 months, and for those of greater draft 4 to 5 months. Steamboats of light draft can ascend to Burksville (238 miles) for from 5 to 7 months and large boats 4 or 5 months.

The appropriations for this section from 1876 to 1884, amounting to \$327,000, were expended in clearing the channel of snags and other surface obstructions, excavation at worst shoals, with use of wing dams, and has resulted in an increased depth at several of the principal obstructions, giving a safer and longer period of navigation.

The instrumental surveys made in 1882 and 1883 from the head of Smiths Shoals to Nashville furnish the basis of the present project for the radical improvement of the Cumberland River above Nashville. The plans made under these surveys provided for 23 locks between Nashville and Point Burnside, and 7 locks for Smiths Shoals, at an estimated cost of \$4,077,922.

Locks of larger dimensions than those contemplated in the original project and estimates having been recommended by the Board of Engineers and approved by the Chief of Engineers and Secretary of War, it has become necessary to revise these estimates. Plans and estimates for locks Nos. 1 and 2 have been prepared and contracts for portions of the work have been made, from which it is now estimated that each lock and dam will cost not less than \$250,000. An estimate of the section from Nashville to Point Burnside, provided 23 locks be found necessary, amounts to \$5,750,000, and to continue the improvement to the head of Smiths Shoals, with 7 additional locks and dams of equal cost, would amount to \$1,750,000 more, or a total of \$7,500,000, an increase of the original estimate by \$3,422,078, which modification is made and submitted in this report. By increasing the lift of the locks it may be found possible to decrease their number and thus complete the improvement at a reduced cost.

The act of August 5, 1886, appropriating \$75,000, specifically provided for this work of canalization "with a view to secure in the channel a depth of 4 feet, commencing with the lock at or near the lower island

at Nashville," and was followed by the appropriations of August 11, 1888, \$200,000, and of September 19, 1890, \$250,000.

The amount expended, including outstanding indebtedness, to the close of the fiscal year, June 30, 1890, for the construction of locks and dams under the existing project was \$47,762.13, the \$50,000 appropriated by act of July 5, 1884, having been expended in channel work, as hereinbefore stated. This sum of \$47,762.13 was applied, as provided by said act, in the examination and purchase of lands for sites, construction of Lock No. 1, lockkeeper's house, and contingencies pertaining to the entire work.

Lock and Dam No. 1.—The construction of Lock No. 1 was continued by the contractors, Holmes & Wilk, through the months of July, August, September, and October, when work was suspended on account of high water. Work was resumed in May, as soon as the stage of water permitted, and has been in progress since. Unusually high water has prevailed during the past two seasons, there having been but 69 days when the stage of water permitted of the contractors working upon the lock site. During the fiscal year the contractors have been able to remove only 1,699 cubic yards of earth and 10,855 cubic yards of rock from the lock pit. Eight hundred and forty-two and one-half cubic yards of stone were quarried and cut and accepted by the United States for the masonry of the lock.

The style of dam to be constructed in connection with Lock No. 1 was referred to a Board of Engineer Officers consisting of Col. G. M. Poe, Lieut. Col. W. E. Merrill, and Lieut. Col. J. W. Barlow. This Board, in report to the Chief of Engineers dated November 16, 1889, gave a contingent approval to the construction of a movable dam of the bear-trap style, but recommended that its final adoption be postponed until the results of the working of the dam then in use at Davis Island, Ohio River, be made known. At a subsequent session this Board, in report to the Chief of Engineers dated November 26, 1890, withdrew the contingent approval of the bear-trap dam, and a fixed dam as outlined in the report dated March 30, 1887 (see Annual Report of the Chief of Engineers for 1888, pages 1622 to 1626), was approved, the preparation of the project in detail being "left to the local engineer." The Board of Engineer Officers in report of November 25, 1890, recommended that in the case of Lock No. 2 certain points be further examined, and these recommendations were embodied in the detailed project for lock, dam, and abutment at the site of Lock and Dam No. 1, transmitted to the Chief of Engineers March 9, 1891. This detailed project was referred to Board of Engineers constituted by Special Orders No. 17, Headquarters Corps of Engineers, Washington, D. C., March 14, 1891, consisting of Col. William P. Craighill, Maj. A. Mackenzie, and Maj. D. W. Lockwood, all of the Corps of Engineers. In their report of April 20, 1891, to the Chief of Engineers, the Board states that it does not appear necessary to make specific provision in connection with masonry for the use of turbines or Fontaine valves; approves the plan of dam and the modified plan of the abutment; recommends the use of ordinary balanced valves in place of Fontaine valves for the filling culverts; approves the plan of steel gates similar in design to the gates now in use on the Muscle Shoals Canal; suggests that no provision be made at present for other than hand power in connection with the appliances for operating the gates and valves.

During the fiscal year contract was entered into with Henry F. Holmes on October 17, 1890, for the construction of the masonry of Lock No. 1. A further increase in the amount of masonry beyond existing contracts

points above Nashville as fast as the locks can be completed and utilized, and for the upper river the opening up of a cheap and safe means of transportation for the almost unlimited mineral and forest resources of the Upper Cumberland Valley. A steamboat line is operating between Burksville and the head of navigation, Burnside, independent of the Nashville trade.

It is deemed advisable to repeat the recommendation of the last Annual Reports:

That the section of river from Burnside to the Kentucky State line has claims for immediate improvement quite as great as those on the portion directly above Nashville.

The facilities for carrying on the improvement from Point Burnside are equal, if not superior, to those at Nashville.

Stone for locks, of excellent quality, can be found near at hand, while all other supplies, especially iron, can be obtained via Cincinnati rapidly and at the lowest possible cost.

These considerations lead to the suggestion that it may be advisable to subdivide the Cumberland River above Nashville to head of Smiths Shoals, Kentucky, and the appropriations for its improvement into three sections:

	Miles.
(1.) In Tennessee, above Nashville	130
(2.) In Kentucky, below Point Burnside	197
(3.) At Smith Shoals	10

The amount herein asked for, \$1,000,000, can be profitably expended in the construction of dam and abutment of Lock No. 2, in procuring sites necessary for, and the construction of, Locks and Dams Nos. 3 and 4, and to begin a lock either at the foot of Smith Shoals, or at the upper lock of the series between Nashville and Burnside, or both, if sufficient funds are made available so that the work of lock construction at the three points can be prosecuted in an economical, advantageous, and efficient manner; otherwise, the operations to be confined to the lower locks, 3 and 4, as before stated, and such work as may be found necessary in maintaining a safe, navigable, open-river channel during the period of lock construction. It is respectfully urged that special provision be made for this work of clearing away the surface obstructions brought down by the annually recurring floods, similar in character and effect to that providing for the uninterrupted work of snagging upon the Ohio River in section 13 of the river and harbor act of September 19, 1890.

Original estimate for improving Cumberland River by locks and dams from Nashville to head of Smiths Shoals	\$4, 077, 922. 00
Increased in 1891 to	7, 500, 000. 00
Amount appropriated	525, 000. 00
Amount expended, including outstanding indebtedness and amount covered by contracts	308, 348. 29

Money statement.

July 1, 1890, balance unexpended	\$229, 539. 81
Amount appropriated by act approved September 19, 1890	250, 000. 00
	<hr/>
	479, 539. 81
June 30, 1891, amount expended during fiscal year	31, 221. 21
	<hr/>
July 1, 1891, balance unexpended	448, 318. 60
July 1, 1891, outstanding liabilities	\$459. 05
July 1, 1891, amount covered by uncompleted contracts	231, 207. 84
	<hr/>
	231, 666. 89
	<hr/>
July 1, 1891, balance available	216, 651. 71
	<hr/>

{ Amount (estimated) required for completion of existing project	\$6, 975, 000. 00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	1, 000, 000. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

3 CUMBERLAND RIVER ABOVE MOUTH OF THE JELlico, KENTUCKY.

No work has been done on this section of the river since 1882. The appropriation of \$5,000, made by act of August 2, 1882, and held over and unexpended, was made available by the act of September 19, 1890, for expenditure, and to "be applied to the removal of snags and sand bars in the said Cumberland River above Nashville, Tenn."

The sum of \$3,374.46 has been so expended during the fiscal year. For work done see "Above Nashville."

Money statement.

July 1, 1890, balance unexpended and available by act approved September 19, 1890	\$5, 000. 00
June 30, 1891, amount expended during fiscal year	3, 374. 46
July 1, 1891, balance unexpended	1, 625. 54
July 1, 1891, outstanding liabilities	815. 52
July 1, 1891, balance available	810. 02

Abstract of proposals for part construction of dike near Smithland, Ky., below mouth of Cumberland River.

[Opened February 27, 1891, by Lieut. Col. J. W. Barlow, Corps of Engineers.]

No.	Name and residence of bidder.	Piles in place (2,100).		Timber oak, in place, (35,000 feet, B. M.).		Stone riprap in place (9,600 cubic yards).		Brush in place (3,500 cords).		Bolts, nuts, and washers, in place (4,500 pounds).		Grand total cost.
		Each.	Total cost.	Per M feet, B. M.	Total cost.	Per cubic yard.	Total cost.	Per cord.	Total cost.	Per pound.	Total cost.	
1	Frederick Hartweg, Cincinnati, Ohio.	\$2.00	\$4,200	\$22.50	\$787.50	\$0.94	\$9,024	\$0.79	\$2,765	\$0.04	\$202.50	\$16,979.00
2	Henry C. Jones, Madison, Ind.	2.00	4,200	22.00	770.00	.93	8,928	.90	3,150	.05	225.00	17,373.00
3	A. J. Whitney, Rock Island, Ill.	2.00	4,200	24.00	840.00	1.15	11,040	1.00	3,500	.06	270.00	19,850.00
4	T. J. Hardin & Co., Monterey, Ky.	2.45	5,145	27.00	945.00	.97	9,312	1.55	5,425	.07	315.00	21,142.00
5	Wm. Kirk, Madison, Ind.	2.50	5,250	15.00	525.00	1.40	13,440	1.25	4,375	.03	135.00	23,725.00
6	J. W. Gardner, Galipolis, Ohio.	3.00	6,480	29.90	1,046.50	1.14	10,944	2.09	7,315	.14	630.00	26,424.50
7	I. V. Hoag, Jr., Pittsburgh, Pa.	3.00	6,300	25.00	875.00	1.50	14,400	2.50	8,750	.04	219.38	30,544.38

* Certificate to guaranty informal.

Contract entered into with Frederick Hartweg March 12, 1891.

2276 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of proposals for completion of masonry of lock No. 1, Cumberland River.

[Opened September 23, 1890, by Lieut. Col. J. W. Barlow, Corps of Engineers.]

No.	Name and residence of bidder.	Lock construction—masonry.						Cost.
		Backing (1,985 cubic yards).	Rock face (408 cubic yards).	Pointed face (650 cubic yards).	Coping, fine pointed (330 cubic yards).	Quoins (30 cubic yards).	Bolt holes (100 linear feet).	
		Per cu. yd.	Pr. cu. yd.	Pr. cu. yd.	Pr. cu. yd.	Pr. cu. yd.	Pr. lin. ft.	
1	Henry T. Holmes, Nashville, Tenn.	\$8.50	\$11.00	\$12.00	\$16.00	\$30.00	\$1.50	\$35,490.50
2	L. M. Pettit, Cincinnati, Ohio*.....	10.00	13.00	15.00	25.00	.....	.50	43,204.00

* Certificate not given by United States official.

Contract entered into with Henry F. Holmes October 17, 1891.

Abstract of proposals for building cofferdam, excavating lock pit, and completion of masonry of Lock No. 2, Cumberland River.

[Opened February 12, 1891, by Lieut. Col. J. W. Barlow, Corps of Engineers.]

No.	Name and residence of bidder.	Grubbing and clearing complete site.	Cofferdam (650 linear feet).		Excavation.		Embankment (6,500 cubic yards).		Puddling (800 cubic yards).	
			Per linear foot.	Total cost.	Earth (16,000 cubic yards) per cubic yard.	Rock (2,000 cubic yards) per cubic yard.	Per cubic yard.	Total cost.	Per cubic yard.	Total cost.
1	I. V. Hoag, jr., Pittsburg, Pa.	\$500	\$25	\$16,250	\$1.25	\$3.00	\$0.65	\$4,225	\$1.50	\$1,200
2	Chas. A. Locke, Nashville, Tenn.	100	23	14,950	.60	1.95	.60	3,900	1.10	880
3	Charles Rich and Henry F. Holmes, Nashville, Tenn.	200	19	12,350	.50	2.00	.50	3,250	1.00	800
4	Wm. Patrick, Phoenix, N. Y.	500	23	14,950	.55	3.00	.60	3,900	.70	560

No.	Name and residence of bidder.	Lock construction—masonry.							Arches.	
		Pointed face (2,650 cubic yards) per cubic yard.	Rock face (1,250 cubic yards) per cubic yard.	Backing (6,300 cubic yards) per cubic yard.	Coping (300 cubic yards) per cubic yard.	Sills (70 cubic yards) per cubic yard.	Quoins (115 cubic yards) per cubic yard.	Stone (125 cubic yards) per cubic yard.	Brick (125 cubic yards) per cubic yard.	
1	I. V. Hoag, jr., Pittsburg, Pa.	\$19.75	\$19.75	\$9.00	\$19.75	\$19.75	\$19.75	\$19.75	\$17	
2	Chas. A. Locke, Nashville, Tenn.	16.00	14.35	10.00	20.50	17.30	37.00	20.70	19	
3	Charles Rich and Henry F. Holmes, Nashville, Tenn.	13.50	12.50	8.50	26.00	25.00	30.00	25.00	19	
4	Wm. Patrick, Phoenix, N. Y.	21.50	12.25	10.50	24.00	29.00	29.00	16.00	11	

Abstract of proposals for building offerdam, excavating lock pit, etc.—Continued.

No.	Name and residence of bidder.	Lock construction—masonry.				Grand total cost.
		Paving (750 cubic yards) per cubic yard.	Concrete (1,000 cubic yards) per cubic yard.	Bolt holes, etc. (500 linear feet) per linear foot.	Total cost.	
1	I. V. Hoag, Jr., Pittsburg, Pa.	\$7	\$8.50	\$0.70	\$161,997.50	\$210,172.50
2	Chas. A. Locke, Nashville, Tenn.	4	8.30	.75	151,591.00	184,921.00
3	Charles Rich and Henry T. Holmes, Nashville, Tenn.	5	7.00	1.50	134,950.00	163,550.00
4	Wm. Patrick, Phoenix, N. Y.	3	4.50	.40	161,827.50	196,037.50

Contract entered into with Rich & Holmes February 24, 1891.

COMMERCIAL STATISTICS.

Cumberland River above and below Nashville, Tenn., from July 1, 1890, to June 30, 1891.

Articles.	Above Nashville.	Below Nashville.	Articles.	Above Nashville.	Below Nashville.
Brick tons..	408	527	Lumber tons..	13,515	12,125
Cattle do..	818	400	Logs do..	8,000	.....
Coal do..	350	142	Merchandise do..	12,227	17,865
Flour do..	1,402	638	Sand do..	21,900	7,500
Grain do..	3,059	11,772	Salt do..	1,421	500
Hay do..	92	577	Shingles do..	20	125
Horses and mules do..	316	200	Tobacco do..	1,460	3,228
Hogs do..	516	171	Wood do..	61	16,137
Iron do..	363	233	Passengers number..	9,642	7,929

The steamboat companies report that the short crops have been largely the cause of the light freights on the Cumberland River during the past fiscal year.

Cumberland River above Nashville, between Burnside, Ky., and Butler Landing, Tenn., distance 143 miles.

Articles.	Tons.	Articles.	Tons.	Articles.	Tons.
Cattle 652		Hogs 71		Merchandise 2,646	
Flour 117		Lumber 249		Logs 10,870	
Grain 431		Salt 1,000		Posts (cedar) 273	
Hay 129		Tobacco 147			
Horses and mules 39		Staves 7,625			

Number of passengers, 2,170.

Steamers (stern wheel).	Length.	Breadth.	Depth.	Tonnage.
	Feet.	Feet.	Feet.	
Clayton H. Webb	110	25	3	90.98
Crescent	80	16	3	34.54

These steamers made 13 trips between Burnside and Butler Landing, and 111 trips only to intermediate points.

2278 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

List of steamboats (stern wheel) plying on Cumberland River below Nashville.

Name.	Length.	Breadth.	Depth.	Tonnage.	Draft.	
					Light.	Loaded.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>		<i>Inches.</i>	<i>Feet.</i>
E. G. Ragon.....	165	31	5	309	22	6
Dover.....	120	20	2½	79	12	3
B. S. Rhea.....	165	30	4	203	25	5
J. P. Drouillard.....	165	31	5	203	22	6
John Fowler.....	149	28	3		18	4½
Chas. A. Blackman.....	61	18	3	25.26	22	
E. T. Holman.....	68	17	3	82		

The above steamers made 55 trips between Nashville, Tenn., and Evansville, Ind., and 45 trips between Nashville, Tenn., and Paducah, Ky.

List of steamboats (stern wheel) plying on Cumberland River above Nashville.

Name.	Length.	Breadth.	Depth.	Tonnage.	Draft.	
					Light.	Loaded.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>		<i>Inches.</i>	<i>Feet.</i>
I. T. Rhea.....	150	30	4½	198.54	18	4½
J. J. Odil.....	149½	28½	3	220.18	16	3½
John Fowler.....	149	28	3		18	4½
J. W. Hart.....	165	28	3		18	
Pearl.....	140	24	2	73.98	16	2

The above named steamers made 78 round trips from Nashville, Tenn., to Burnside Ky., and 13 trips from Nashville to Obed (Obey) River and return.

PROJECT OF LIEUTENANT-COLONEL J. W. BARLOW, CORPS OF ENGINEERS, FOR LOCK, DAM, AND ABUTMENT AT LOCK AND DAM NO. 1, CUMBERLAND RIVER, TENNESSEE.

ENGINEER OFFICE, U. S. ARMY,
Nashville, Tenn., March 9, 1891.

GENERAL: I have the honor to submit herewith the following detailed project for lock, dam, and abutment at the site of Lock and Dam No. 1, Cumberland River, as proposed by the Board of Engineer Officers convened by Special Orders No. 68, Headquarters Corps of Engineers, October 16, 1889, and rendered in compliance with indorsement of December 5, 1890, on copy of report of said Board dated November 26, 1890.

A general plan of the site, to which reference is invited, showing the location of the proposed works, was forwarded to the Department with my letter of June 28, 1888.

The report of the Board of Engineers of November 26, 1890, discusses only the subject of the dam, but as the indorsement requires a project for both lock and dam, it is believed that the report of November 25, 1890, by the same Board upon Lock No. 2, Cumberland River, should serve as a guide in proposing a project for Lock No. 1.

I therefore transmit herewith:*

* Not printed.

1. A tracing showing cross-section plan and elevation of the proposed dam for Lock No. 1. The design for this dam has been adopted, after careful consideration of the latest practice in dam building, especially on the Monongahela and Muskingum rivers, and is believed to possess requisite strength and durability. The foundation being of solid rock, no danger of undermining is anticipated.

2. Tracing showing proposed method of constructing the abutment, including cross section, plan, and elevation. The river side of this abutment will be of rock-face masonry, except where it is joined by the dam, and there the surface and the coping will be of pointed-face. Crib work filled with stone will be carried downstream from the lower end of abutment as far as may be found necessary to protect the bank from scour. Paving will also be added where required.

3. Tracing showing plan, elevation, and cross section of lock.

These drawings conform in all respects to the suggestions made by the Board for Lock No. 2, including use of four independent turbines for operating the gates and valves. This drawing does not show the location and arrangement of the necessary shafts, pulleys, etc., for transmitting the power to the moving parts of the lock. This subject will be more fully discussed at a subsequent period, after further consideration.

I am not now entirely convinced that turbines will be as desirable a motive power as steam, on account of the varying head of water, which will at times be reduced to zero and will then necessitate the use of some other power. A further study of this question will be made, and the results submitted as soon as practicable.

My experience in the use of iron gates on the Muscle Shoals Canal strongly inclines me to recommend their adoption on the Cumberland River. This question was left open for further experience, which I now think sufficiently warrants my favorable conclusion. Detailed drawings of the proposed gates, method of suspension, etc., will be submitted in a subsequent report, together with the plans to be recommended for operating machinery.

The method of constructing the lock by contract has already been approved, and contracts for the masonry are now in force.

It is recommended that the lock approaches, dam, and abutment be constructed by contract after advertising in the usual way.

Following are estimates for completion of lock and approaches, dam, and abutment, in detail, except for operating machinery, which is necessarily approximate. The latter will be submitted with the detailed report thereon.

An increase in the amount of masonry beyond existing contracts is necessary and is due to the substitution of masonry in the land wall for natural rock, at first thought practicable, and to the change in height of walls resulting from the adoption of a fixed dam instead of a movable dam by the Board of Engineers and approved by the Chief of Engineers.

	Cubic yards.
Amount of masonry required	12, 070
Amount of masonry under contract.....	7, 547
Amount unprovided for, due to substitution of masonry for natural rock	2, 123
Amount due to increased height of walls.....	2, 400

The first of these items ought properly to be added to the contract of Holmes & Wilk, dated September 19, 1888, and the second to that of H. F. Holmes, dated October 17, 1890.

2280 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Estimate of cost of Lock No. 1 and its approaches, dam, and abutment.

Cofferdam, built	\$6,021	
Excavation, lock pit, part completed	23,425	
Masonry under contracts	76,675	
Masonry unprovided for by contracts	39,384	
Excavation above lock	10,000	
Guard cribs	2,155	
Grading and paving bank	6,550	
Gates and operating machinery	20,000	
		\$184,210
Fixed dam		47,500
Abutment:		
Masonry, estimated at prices bid by Holmes & Wilk, August 6, 1889	8,421	
Shore protection, grading and paving bank	2,267	
		10,688
Grand total		242,398

Very respectfully,

J. W. BARLOW,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 12, 1891.

Respectfully submitted to the Secretary of War with recommendation that the within project be referred to a Board of Engineers to consist of Col. W. P. Craighill, Maj. A. Mackenzie, and Maj. D. W. Lockwood, of the Corps of Engineers, for consideration and report; the Board to meet at Nashville, Tenn., upon the call of the senior member.

With approval of the Secretary the order constituting the Board will be issued from this office and the expenses of the Board will be paid from appropriation for improving Cumberland River above Nashville.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

WAR DEPARTMENT,
March 13, 1891.

Approved as recommended by the Chief of Engineers.

By order of the Acting Secretary of War.

SAML. HODGKINS,
Acting Chief Clerk.

REPORT OF BOARD OF ENGINEERS ON PROJECT FOR LOCK, DAM, AND ABUTMENT AT LOCK AND DAM NO. 1, CUMBERLAND RIVER, TENNESSEE.

GENERAL: The Board of Engineer Officers, constituted by Special Orders No. 17, Headquarters, Corps of Engineers, Washington, D. C., March 14, 1891, "to consider and report upon a project for lock, dam, and abutment at site of Lock and Dam No. 1, Cumberland river," met at Nashville, Tenn., on April 10, 1891.

Having visited and examined the site as thoroughly as the stage of the river permitted, and considered fully the plans presented and all available information bearing upon the work, the Board has the honor to submit the following report.

The instructions of the Board are found in an indorsement of the Chief of Engineers, dated March 14, 1891, on the project submitted by Lieut. Col. Barlow, Corps of Engineers, under date of March 9, 1891, and they require the consideration of and a report upon the subject matter of such project.

The project presents plans for the masonry of a lock, for a fixed dam, and for the abutment of such dam. Reference is made in the project to the general plan of site, forwarded to the Chief of Engineers with letter of June 28, 1888. The project also refers to the relative advantages of turbines and steam power for operating gates and valves, the use of iron gates, the substitution of masonry for natural rock in the land wall, the method of carrying out work on dam and abutment, and gives estimates of cost of the work. The plans proposed by the local engineer for the gates, valves, and for operating machinery were presented to and considered by the Board.

A Board of Engineer Officers, which was constituted by Special Orders No. 43, Headquarters, Corps of Engineers, Washington, D. C., March 12, 1887, submitted, under date of March 30, 1887, a report upon Lock and Dam No. 1, Cumberland River (pages 1622-1626, Report of Chief of Engineers for 1888). In this report the dimensions of lock, location of lock and dam, and the details of lock, fixed dam, and abutment are thoroughly discussed and recommendations are made. The recommendations of the Board were approved by the Chief of Engineers and the Secretary of War.

A second Board of Engineer Officers, constituted by Special Orders, No. 68, Headquarters Corps of Engineers, Washington, D. C., October 16, 1889, to consider the proposed dam at Lock No. 1, Cumberland River, in a report dated November 16, 1889, gave a contingent approval to the construction of a movable dam instead of the fixed dam proposed by the first Board. This Board, in a subsequent report dated November 26, 1890, for reasons therein given, withdrew its former suggestion and recommended the construction of a fixed dam, as at first proposed. This Board also had under consideration the plans, elevation, and cross sections of Lock No. 2, Cumberland River, and approved of the same, with some slight modifications. The first report of this Board (report of Chief of Engineers for 1890, pages 2143 *et seq.*), received the approval of the Chief of Engineers and Secretary of War, and the subsequent reports have been favorably acted upon by the Chief of Engineers.

The lock.—The plan, elevation, and cross sections for Lock No. 1, Cumberland River, presented by Lieutenant-Colonel Barlow, Corps of Engineers, with his project dated March 9, 1891, are in accordance with the recommendations of the report of the Board of Engineers dated March 30, 1887, and are almost identical with the plans as approved by a Board in a report dated November 25, 1890, for Lock No. 2. Contracts for the excavation of the lock pit and for the masonry of lock have been entered into, and the former work is well under way.

The plans presented are recommended for approval, with the suggestion that, for reasons hereafter given, it does not appear necessary to make special provision, in connection with masonry, for the use of turbines or Fontaine valves.

The dam.—The dam proposed is similar in construction to those in

successful use on the Monongahela and Muskingum rivers, and is in accordance with the recommendations of the Boards of Engineers which have had this dam under careful consideration.

The plan of the dam as presented is recommended for approval.

The abutment.—The Board of Engineer Officers considering Lock and Dam No. 1, Cumberland River, in 1887, made certain recommendations as to the abutment of the dam. A plan for an abutment, in connection with a fixed dam and based on such recommendations, was submitted to the Chief of Engineers and approved under date of June 18, 1889. This plan definitely located the abutment and fixed the length of the dam at 432 feet. Work on the abutment, under the approved plan, was advertised and proposals for the construction under formal contract were received, but no contract for the work was entered into, in consequence of a reopening of the question of movable and fixed dams.

The plans of the abutment, presented for the consideration of this Board with the project of March 9, 1891, are adapted to a fixed dam, and are a modification of the approved plan made by the local engineer upon the suggestions of the Board of Engineers which had under consideration the question of fixed or movable dam, the modification being made with a view to reducing the amount of masonry without affecting the efficiency of the structure.

Either the form of abutment which has been approved or the modification of such form now presented for consideration would serve the purposes for which it was intended; but it is the opinion of this Board that a still further reduction of masonry can be made without affecting efficiency by reducing the height of abutment to the height of the bank where the face of the abutment meets the natural slope, by giving the top of the wing wall or T the same slope as the natural bank, and by the protection of the slope of the bank above and back of the abutment by substantial paving. The modifications are in accord with the views of the local engineer, who has submitted to the Board a plan embodying the changes proposed.

Valves.—Plans contemplating the use of Fontaine valves for the filling culverts and ordinary balanced valves for the emptying culverts were presented to the Board by the local engineer for consideration. The operation of the Fontaine cylindrical valve may be yet considered as an experiment, but the successful working of the ordinary balanced valve, as proposed by the local engineer for the emptying culverts, is a fixed fact. It is therefore recommended that the balanced valves be used for the filling culverts as well as for the emptying culverts.

Gates.—Plans for steel gates, similar in design to but having greater strength than the gates now in use on the Muscle Shoals Canal, have been presented by the local engineer and considered. The Board approves of the plans.

Machinery for operating gates and valves.—The original plans for Lock 1, Cumberland River, proposed the use of a turbine wheel for moving gates and valves. The Board of Engineers, in its report of November 25, 1890, suggested the use of four independent turbines. In the project of March 9, 1891, the local engineer suggests that "on account of the varying head, which may at times be reduced to zero," steam may be the more desirable power. The Board is of the opinion that, under the circumstances, steam would be more reliable than water power; but it is of the further opinion that, inasmuch as the use of this lock will be very limited for many years to come, it is not necessary to make any provision at present time for other than hand power, use being made of

appliances in common use; that is, of simple spars for operating gates and of gearing and small capstans for operating the valves.

Estimates.—Many of the items, and the largest ones, in the estimate of cost of Lock No. 1, dam, and abutment, are based on actual contract prices. The items for gates and operating machinery can be reduced somewhat, if approval is given to the recommendation that no provision be made at present for other than hand-power for operating gates and valves. A corresponding increase may be required in item of abutment, to provide for crib work mentioned in project but not referred to in estimate. It is desirable that an item be added to the estimate for contingencies.

The Board would respectfully recommend that the project be approved, subject to the modifications hereinbefore mentioned as to abutment, valves, power for operating gates, and estimates.

Respectfully submitted.

BALTIMORE, MD., *April 20, 1891.*

ROCK ISLAND, ILL., *April 16, 1891.*

CINCINNATI, OHIO, *April 18, 1891.*

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

A. MACKENZIE,
Major, Corps of Engineers.

D. W. LOCKWOOD,
Major, Corps of Engineers.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
April 22, 1891.

Respectfully submitted to the Secretary of War.

By indorsement of November 23, 1889, the Secretary of War approved a modification of the then existing project for dam at Lock No. 1, Cumberland River, so as to authorize a movable dam at that point.

A Board of Engineers subsequently, November 26, 1890, recommended the abandonment of the plan for a movable dam at the site of Lock No. 1, and by authority of the Secretary of War a new Board was constituted by Special Orders, No. 17, Headquarters Corps of Engineers, March 14, 1891, to consider and report upon a project for lock, dam, and abutment at this site.

The within report of this latter Board contemplates the construction of a fixed dam, and the views and recommendations are concurred in and submitted with recommendation for approval.

H. M. ADAMS,
Major, Corps of Engineers, in Charge.

[Second indorsement.]

WAR DEPARTMENT,
April 25, 1891.

The within report of the Board of Engineers is approved as recommended by the officer in charge of the office of the Chief of Engineers.

L. A. GRANT,
Acting Secretary of War.

E E 6.

IMPROVEMENT OF CANEY FORK RIVER, TENNESSEE.

This stream rises in the plateau of the Cumberland Mountains near Sparta, Tenn., and discharges into the Cumberland River at Carthage, about 116 miles above Nashville. The Caney Fork River, about 200 miles long, and having its course and watershed wholly in Tennessee, is navigable to Frank Ferry, about 92 miles from its mouth.

Under provisions of act of Congress approved June 18, 1878, an examination was made early in 1879 from the mouth of the river to Sligo Ford, 72 miles. (See Report of Chief of Engineers, 1879, pages 1275-1277.) In compliance with provisions of act of Congress approved July 5, 1884, the examination of 1879 was extended in 1876 from Sligo Ford to Frank Ferry, a distance of 20 miles. (See Report of Chief of Engineers, 1887, pages 1768-1771.) The channel was found to be obstructed by rock reefs, sand and gravel bars, snags, and overhanging trees.

The present project, based on the results of these two examinations, is to improve the 92 miles of river from Frank Ferry to its mouth by removing the surface obstructions and building necessary dams and training walls so as to obtain sufficient water for safe navigation for steamboats drawing not more than 3 feet during the usual boating season of about 5 months, from February to July.

The following appropriations have been made for this work:

Acts of—	
June 14, 1880.....	\$6,000
March 3, 1881.....	4,000
August 2, 1882.....	4,000
July 5, 1884.....	3,000
August 5, 1886.....	3,000
August 11, 1888.....	2,500
September 19, 1890.....	2,500
Aggregate	25,000

The amount expended to June 30, 1890, including outstanding indebtedness, was \$22,441.99, which was used in removing snags, overhanging trees, in reducing gravel and sand bars, in repairing and building wing dams. The channel to Sligo Ford, when the river is at a 3-foot stage above low water, being very much improved, especially at Chandler Island Shoals and Trousdale Ferry.

No funds were available at the beginning of the fiscal year, and the appropriation of September 19, 1890, was made too late to take advantage of the low-water season of that year.

Active operations were resumed June 1, the water having reached a stage sufficiently low for good work in the channel. As provided by the act of September 19, 1890, work was begun "in accordance with last survey" in the channel at Frank Ferry and extended to the foot of Mine Lick Shoals, a distance of 37 miles, by the close of the fiscal year. The upper portion of the channel, from Frank Ferry to Sligo Ford, was especially improved by the partial removal of some 8 fish-trap dams and other surface obstructions, which work will be of great benefit to the rafts and flatboats coming down on the next "rain tides."

The following table shows in detail the character, amount, and location of the work done:

Locality.	Tree out.	Snags removed.	Rock removed.	Distance from Frank Ferry.	Locality.	Trees out.	Snags removed.	Rock removed.	Distance from Frank Ferry.
			<i>C. yds.</i>	<i>Miles.</i>				<i>C. yds.</i>	<i>Miles.</i>
Frank Ferry Island	200	5	25		Bluff Point.....	37	14	50	18
Mussey Island		3	27	1	Copperas Cave Shoals..	107		34	19
Goodson Bars	47		24	1½	Fall Creek Point	138			19½
Three Islands	402	5	75	2	Sligo Landing *	13			21½
Dishmael Fish Trap	150		40	3	Lockhardt Shoals	43		7	22½
Slick Rock Shoals	375		24	4	Upper Allen Shoals	17			26½
Stink Creek Shoals	490	15	38	7½	Darkey Eddy Islands † ..	251			30
Bain Island	125		25	8½	Point opposite Narrows.	12			32
Cow Horn Island	531		47	9½	Phillips Island	450			33½
Pine Creek Shoals	75		5	13½	Lower Allen Shoals	313			34½
Indian Shoals	213			14½	Howard Shoals	73			35
Pinegar Island	47			15½	Mine Lick Shoals	430			37
Certain Shoals			18	16½					
Love Island	248	7		17½	Total	4,787	49	439	

* Between Frank Ferry and Sligo Ford 8 fish-trap dams were removed.

† At Darkey Eddy Island 1 dam 75 feet long was built; 25 cubic yards of rock, 75 cubic yards of gravel, and 20 cords of brush were placed in dam.

During the fiscal year the commerce of the Caney Fork River has been entirely in rafts, no steamboats having plied upon that stream. The merchants say that it is impracticable this year to separate and report the number of logs received from the Caney Fork and the Upper Cumberland.

The amount expended during the fiscal year, including outstanding indebtedness, was \$930.50.

Estimate for improving Caney Fork River from its mouth to Frank Ferry	\$45,228.00
Amount appropriated	25,000.00
Amount expended, including outstanding indebtedness	23,353.49

Money statement.

July 1, 1890, balance unexpended	\$77.01
Amount appropriated by act approved September 19, 1890	2,500.00
	2,577.01
June 30, 1891, amount expended during fiscal year	41.77
July 1, 1891, balance unexpended	2,535.24
July 1, 1891, outstanding liabilities	888.73
July 1, 1891, balance available	1,646.51

{ Amount (estimated) required for completion of existing project	20,228.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	20,228.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

E E 7.

IMPROVEMENT OF SOUTH FORK OF CUMBERLAND RIVER, KENTUCKY.

The junction in Tennessee of Clear Fork and New River forms the South Fork of Cumberland River. From the junction of these streams the river follows a northerly course of about 88 miles and enters the Cumberland River near Burnside, Ky., about 2 miles below Smiths Shoals.

It was found, on an examination made under provisions of act of June 14, 1880, that this stream could not be navigated on its upper waters owing to the presence of great sandstone bowlders, which it was impossible to remove. Its lower waters, for a distance of 44 miles from its mouth, were found to be considerably obstructed by gravel and sand bars, rock reefs, and surface obstructions. It was, however, deemed feasible to reduce the reefs and bars, and clear the channel of drift, snags, and overhanging trees, and by the use of wing dams to contract and deepen the channel. The project as adopted looks to this necessary improvement so as to obtain a safe channel for the passage of flatboats and rafts at a stage of the river not lower than 3 feet above average low water, the improvement to extend from Devils Jumps to the mouth, a distance of about 44 miles.

The following appropriations have been made for this work:

Act of—	
August 2, 1882	\$3, 000
July 5, 1884	4, 000
August 5, 1886	5, 000

These sums, aggregating \$12,000, have been expended principally at Sloan Shoals and Robert Mill Shoals. The channel has been considerably improved and cleared of surface obstructions for a distance of about 16 miles above the mouth of the river.

No appropriation has been made for this improvement since the act of August 5, 1886, and consequently no work has been done during the fiscal year ending June 30, 1891.

Estimates for improving south fork of Cumberland River, Kentucky:	
From Kentucky line to Devils Jumps	\$27, 538.00
From Devils Jumps to mouth of river	35, 265.00
Total estimate	62, 803.00
Amount appropriated	12, 000.00
Amount expended, including outstanding indebtedness	11, 968.94

Money statement.

July 1, 1890, balance unexpended	\$41. 03
July 1, 1891, balance unexpended	41. 03
July 1, 1891, outstanding liabilities	9. 97
July 1, 1891, balance available	31. 06

{ Amount (estimated) required for completion of existing project	50, 803.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	15, 000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

South Fork of Cumberland River, Kentucky, from July 1, 1890, to June 30, 1891.

Logs	Tons. 20, 112
Lumber	8, 000
Posts (cedar)	790

E E 8.

PRELIMINARY EXAMINATION OF LITTLE PIGEON RIVER, TENNESSEE,
FROM MOUTH TO SEVIERVILLE.*[Printed in House Ex. Doc. No. 159, Fifty-first Congress, second session.]*OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 7, 1891.

SIR: I have the honor to submit the accompanying copy of report, dated January 3, 1891, by Lieut. Col. J. W. Barlow, Corps of Engineers, giving results of a preliminary examination of Little Pigeon River, from mouth to Sevierville, Tenn., made in compliance with requirements of the river and harbor act approved September 19, 1890.

Colonel Barlow states that the improvement of the locality could only be effected by heavy rock excavations through a number of reefs, or by the construction of locks and dams, in either case involving an expense which does not seem warranted by the conditions now existing. He is therefore of the opinion that Little Pigeon River from mouth to Sevierville is not at present worthy of improvement by the United States, and in this opinion I concur.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

HON. REDFIELD PROCTOR,
Secretary of War.

REPORT OF LIEUTENANT-COLONEL J. W. BARLOW, CORPS OF ENGINEERS.

ENGINEER OFFICE, U. S. ARMY,
Nashville, Tenn., January 3, 1891.

GENERAL: I have the honor to present herewith, in compliance with instructions contained in Department letter of September 20, 1890, the report of a preliminary examination of "Little Pigeon River from mouth to Sevierville," as provided for in act of Congress approved September 19, 1890.

This river is formed by two branches, known as East Fork and South Fork, which join at Sevierville, in East Tennessee. The river flows in a northwesterly course about 5 miles and empties into the French Broad River about 42 miles above Knoxville. The French Broad River itself is badly obstructed by rock reefs and is not navigable at its low stages. The navigation of little Pigeon River being dependent upon that of the French Broad, it would be useless to do more than to provide for navigation during its medium and higher stages.

I personally visited this river on the 29th and 30th of December, 1890, and made such examination as was possible without the aid of instruments. Though the river was not at its lowest stage, I crossed it twice by fording in traveling from near its mouth to Sevierville, the depth at each ford being from 12 to 24 inches. The shoal and rapids were plainly visible from the banks, and are generally of solid rock, though gravel has been deposited in places, also forming troublesome shoals. It is reported that in very dry seasons there is so little water that the

shoals are scarcely covered. There are six of these shoals between Sevierville and Catlettsburg, 3 miles below, and the fall in that distance is estimated to be about 15 or 20 feet. The width of the stream is from 150 to 300 feet.

The object desired by improving this river from mouth to Sevierville, a distance of 5 miles, is to enable boats plying on the French Broad River to run up to Sevierville, which is an excellent receiving and distributing point for a large and rich agricultural territory, whose only means of transportation (except by wagon) is along the French Broad River.

Little Pigeon River, in its present condition, is utilized during the winter months, and as often as possible in summer, for flatboats, which are pushed up and down between Sevierville and the mouth. When practicable, steamboats ascend the Little Pigeon, frequently going up as far as Catlettsburg, about 2 miles, and occasionally during extreme high water to Sevierville. The flatboats connect regularly with the steamboats either at the mouth of Little Pigeon or at some point as high up as the steamers are able to reach. The amount of freight carried in and out of Little Pigeon, as stated by the carriers, is greater than that carried on the French Broad above this stream.

At the time of my visit the local steamboat, *Lucille Borden*, came into the Little Pigeon for freight and passengers, ascending, however, at that stage of water less than a mile from its mouth. I took advantage of this opportunity to float down from Catlettsburg to the steamer, about $1\frac{1}{2}$ miles, on one of the flatboats.

In this section of the stream there is but one bad shoal, which, if removed, would permit light-draft steamers to reach the warehouse below Catlettsburg during the navigable seasons of the French Broad River, and would result in great convenience to the shipping interests. The improvement of Little Pigeon River as far up as the warehouse would, in my opinion, be very desirable, as there is no landing on the French Broad River in this vicinity, and the construction of such a landing and a road leading to it would be difficult, owing to the topography of the country. The cost of this improvement would be moderate, probably about \$10,000, and would, I think, be justified. There is not the same necessity, however, for carrying the work up to Sevierville, as freight can be brought by wagon to Catlettsburg for shipment almost as readily as to Sevierville.

A thorough improvement of Little Pigeon River from mouth to Sevierville could only be made by heavy rock excavation through a number of reefs, or by the construction of locks and dams, in either case involving an expense which does not seem warranted by the conditions now existing. At some future time, when the obstructions on the French Broad have been more completely removed between Knoxville and the mouth of Little Pigeon River, I think it would be advantageous and proper to improve the lower section of the latter stream so as to permit of a more convenient and easy access to the French Broad.

In view of the above, I feel constrained to report that, in my judgment, the Little Pigeon River from mouth to Sevierville is not, at present, worthy of improvement by the General Government, and therefore no additional allotment for surveys is recommended.

Very respectfully, your obedient servant,

J. W. BARLOW,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

E E 9.

PRELIMINARY EXAMINATION OF HARBOR OF SMITHLAND, KENTUCKY.

[Printed in House Ex. Doc. No. 107, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 17, 1890.

SIR: I have the honor to submit herewith the accompanying copy of report dated December 12, 1890, from Lieut. Col. J. W. Barlow, Corps of Engineers, giving results of preliminary examination of harbor of Smithland, Ky., made to comply with provisions of the river and harbor act approved September 19, 1890.

Lieutenant-Colonel Barlow reports that the town front has already been protected to a certain extent by private contribution and that now the citizens desire the General Government to carry on the work, but he does not think that this harbor is worthy of improvement by Congressional appropriation. I concur in the opinion of Lieutenant-Colonel Barlow.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF LIEUTENANT-COLONEL J. W. BARLOW, CORPS OF ENGINEERS.

ENGINEER OFFICE, U. S. ARMY,
Nashville, Tenn., December 12, 1890.

GENERAL: In compliance with Department letter of September 20, 1890, I have the honor to report that on the 1st instant I visited Smithland, Ky., for the purpose of making a preliminary examination of that harbor to ascertain if it is worthy of improvement by the General Government.

Upon consultation with several citizens interested in the prosperity of the place I ascertained that the improvement sought consisted in the construction of a revetment along the front of the town for the purpose of preventing further erosion of the bank by the current and waves of the river during its high stages.

The bank or levee in front of the town, a part of which is used as a landing for steamers, is about 1,800 feet in length, the top being about 44 feet above low water. Of this front about 150 feet in length was paved many years ago on a slope of about 30 degrees, forming a permanent levee. The river current and waves during high water have eaten into the bank along the entire town front, except where protected by the pavement above mentioned. Last year the destruction of the street in front of the business houses had occurred and the buildings themselves seemed threatened. This danger caused the citizens to contribute sufficient means to build an extension of the old pavement, but with a steeper slope and on a cheaper scale, a further distance of about 600

feet.. This will, it is probable, serve the purpose for which it was designed.

The citizens now desire the General Government to carry on this work so as to afford protection to the whole front of the town threatened by future floods and base their claim for assistance upon the reasons given in the accompanying memorandum. I concur in most of their statements presented in this paper, but do not believe that the small spur dam referred to has had any effect whatever in causing the damage to the levee at Smithland, nor do I agree with the sentiment of the people that this work comes properly within the range of river and harbor improvement to be carried on by the United States. I therefore am of opinion that this harbor is not worthy of improvement by Congressional appropriation.

Very respectfully, your obedient servant,

J. W. BARLOW,
Lieutenant-Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

STATEMENT OF CITIZENS OF SMITHLAND, KENTUCKY.

A meeting of the citizens of Smithland, Ky., was hurriedly summoned on Monday, December 1, 1890, for the purpose of conferring with J. W. Barlow, lieutenant-colonel of engineers, U. S. Army, who was present, in reference to work to be done by the General Government at or near the mouth of the Cumberland River.

The following citizens were present, viz: W. W. Stewart, T. D. Presnell, Charles B. Davis, Charles W. Conant, E. P. Haynes, J. D. Clapton, Capt. J. V. Seyster, Charles W. Watts, J. Newton, David Adams, and W. C. Watts.

The meeting was organized by calling Mr. W. W. Stewart to the chair and the appointment of Mr. W. C. Watts as secretary.

Colonel Barlow having stated the object of his visit, and after a full and free expression of views, opinions, etc., it was resolved that the secretary be instructed to furnish Colonel Barlow with a statement as follows:

In March last a petition was sent to Hon. W. J. Stone, member of Congress from this district, praying the General Government to appropriate \$20,000 for the purpose of improving the levee in front of the town of Smithland. That petition was signed not only by nearly every leading citizen of Smithland, but by many citizens of this county, by several of the citizens of Paducah who are interested in the navigation of the Cumberland and Ohio rivers, and by the officers of nearly, if not quite all, of the regular steamers plying the Ohio and Cumberland rivers which pass this point. That petition we have not before us, but it was based upon the following statements of facts, etc.:

(1) That repeated overflows in recent years had so cut away the front or Water street of Smithland, on which the business portion of the town was situated, that a single wagon could scarcely pass along the sand; and that, unless some work was done to check the washing away of the levee, the chief business buildings in the town would soon be undermined and topple into the river.

(2) That, in consequence of the condition of the levee, steamers plying the Ohio and Cumberland rivers found it well-nigh impossible at high water to take on or discharge cargo at Smithland, and hence the appropriation was asked in the interest of commerce; that is, the stream of commerce of the Ohio and Cumberland rivers passing Smithland.

(3) That the landing of such steamers at the wharf or levee in Smithland during high water did serious damage to said levee.

(4) That most of the roads on the peninsula between the Cumberland and the Tennessee rivers concentrated at Smithland, and hence the appropriation asked for was in the interest of the surrounding district which made Smithland their shipping point.

(5) That the injury to the levee at Smithland had certainly to some extent resulted from works done by the General Government. We refer to the two spur dams referred to in Colonel Barlow's report of April 17, 1888 (Appendix A A, page 1626).

Now, there is, we think, no doubt that the channel of the river immediately below Smithland was so diverted by these spur dams as to force the current against the main shore, and thus cut away the levee in front of the lower portion of Smithland; and the General Government, having done the town this injury, should contribute to its restoration.

(6) That about one-half of the population of Smithland is composed of negroes, who are unable to contribute in the way of taxes to the improvement of Smithland Levee.

(7) That for the foregoing reasons Congress was asked in the interests of Smithland, in the interest of the surrounding country which makes Smithland their shipping point, and in the interest of the commerce of the Cumberland and Ohio rivers to make the desired appropriation.

The foregoing petition was, it should be remembered, drawn and signed in March last (1890). A few days later there was another and higher rise in the rivers (say up to 47 feet on the gauge) which, with the swift current (estimated at 5 to 8 miles per hour), did further and serious damage to the levee in front of Smithland. This necessitated immediate action on the part of the citizens of Smithland, and a rock revetment, extending for about 600 feet in front of the town and over that portion of the levee most seriously damaged, was constructed. This hasty and temporary work will, it is now thought, answer the purpose for which it was designed. But this revetment should extend some 1,200 feet farther—say 1,800 feet in all—and the citizens of Smithland have been so heavily taxed to do the work already done that they are powerless to do more.

And here, be it remembered, the appropriation from Congress asked for is further based on the broad foundation of an improvement in the navigation of both the Cumberland and Ohio rivers. It is now quite evident, from the rapid cutting away of the head of Cumberland Island, owing to the increased volume of water coming through the chute and the wearing away of the "points" at the junction of the "chute" with the Cumberland River, that the current of the Ohio River passing through the chute will, when the Ohio happens to be relatively higher than the Cumberland, strike at an angle of about 45 degrees against the levee at the upper portion of Smithland, the tendency of which will be to scoop out and wash away the valley in which the business portion of Smithland is situated. And, should it do so, it is quite evident that the current would cut around and back of the upper end of the dam, which it is proposed to construct from a point immediately below Smithland down the river between the Tow Head and Cumberland Island, and thus materially injure the navigation of both the Ohio and Cumberland rivers at or about the foot of Cumberland Island.

The meeting further desired to extend their thanks to Colonel Barlow for his kindness and courtesy in furnishing such information as he could in reference to the work to be done by the General Government at and about the mouth of the Cumberland River.

W. W. STEWART,
Chairman.
W. C. WATTS,
Secretary.

LETTER FROM MESSRS. WATTS & ADAMS, REAL ESTATE AGENTS:

SMITHLAND, KY., December 8, 1890.

DEAR SIR: Since writing you on the 4th instant we have had a talk with a friend of ours who resides in Shawneetown, Ill., who tells us that since the great overflow of 1884, which did that town serious damage, the State of Illinois appropriated \$50,000 and the General Government \$30,000, and a good levee in front of the town has been constructed. Taking this as a precedent we can see no reason why Congress should not help our town as indicated in petition. Please look into the Shawneetown appropriation.

Yours, very respectfully,

WATTS & ADAMS.

Lieut. Col. J. W. BARLOW,
Corps of Engineers, U. S. A.

E E 10.

PRELIMINARY EXAMINATION OF OBION RIVER, TENNESSEE, FROM ITS MOUTH TO THE CROSSING OF THE LOUISVILLE AND MEMPHIS RAILROAD IN OBION COUNTY.

ENGINEER OFFICE, U. S. ARMY,
Nashville, Tenn., December 23, 1890.

GENERAL: I have the honor to present herewith a report upon the preliminary examination of Obion River from its mouth to the crossing of the Louisville and Memphis Railroad in Obion County, Tenn., made in compliance with act of Congress approved September 19, 1890, and Department letter of September 20, 1890.

This river is formed by several small streams known as North, South, Rutherford, Harris and Big Davidson forks in the northwestern part of the State. It flows in a southwesterly direction through Obion and Dyer counties, and empties into the Mississippi River at Hale's Point. About 4 miles above its mouth it is joined by the Forked Deer River.

An examination of this river was made under Maj. W. H. H. Benyaure's direction, in 1880. (See Report of Chief of Engineers, 1881, pp. 1486-89.) From this report it would appear that the obstructions on this river are almost wholly composed of drift and overhanging trees, the removal of which would render this stream navigable as far as Obion, a distance of about 115 miles, and at which point it is crossed by the line of the Newport News and Mississippi Valley Company. Above this point no improvements have been considered advisable.

This examination, as shown by Major Benyaure's report, was well made, and it is probable that no material changes have occurred in the river since that date.

In his report Major Benyaure states that—

The obstructions to navigation are snags, logs, leaning timber, etc., the removal of which would constitute the principal work to be carried on in order to make the river navigable for the class of boats that navigate the stream. These boats are of the same character as those on the Forked Deer River, the narrowness of the river and the shortness of many of the bends not allowing any but boats of small dimensions to run on the river except in the lower part.

Mr. Harrison's estimate for removing the obstructions as above mentioned, is \$28,809.

The Obion runs through a fine and heavily timbered country, and the principal article of export is lumber, of which vast quantities are annually shipped both in the log and as sawed lumber. Numerous saw-mills line the stream, and they are kept in constant operation. The estimated value of the production is given by Mr. Harrison as upwards of \$2,800,000. The railroads control all the trade of the upper section of the river above Obion Station, the crossing of the Paducah Railroad; below this point the only outlet to the commerce is by steamboat.

For the purpose of obtaining additional commercial statistics and such other information as could be procured from citizens interested in this improvement, Assistant Engineer Benj. B. Smith was directed to visit the locality and also to examine such portions of the river as were readily accessible.

From Mr. Smith's report herewith it appears that the length of the section of river upon which improvements are desired between Obion and the mouth is but 85 miles, instead of 115 as previously reported. Its average width is 150 feet, and depth at low water, 5 feet. The slope of the river is quite gentle, the adjoining country being flat, and there are but two shoals reported below Obion, which are said to be caused by piles of drift, and that these would disappear upon the removal of the drift.

It further appears from Mr. Smith's report that the production of lumber in the valley of the Obion is very large, and would be much greater if better facilities were afforded for marketing, by clearing the river of drifts and snags. The cultivation of wheat is largely increasing, and the production of cattle, sheep, hogs, mules, and horses is extensively carried on. It is also represented that the entire valley suffers from heavy freight rates, which in a great measure prevent development of its natural resources.

Obion, the only town of consequence upon the river, would be an important shipping point by rail, were it not for the fact that Dyersburg, on the Forked Deer River, can obtain much lower rates on account of its water transportation, and therefore draws largely from the territory which should be tributary to Obion.

The Obion River appears to be a more important river than the Forked Deer, receiving both the waters of that stream and the overflow from Reelfoot Lake.

In view of all the above conditions, the Obion River is, in my opinion, worthy of improvement as far up as Obion Station, at the crossing of the Newport News and Mississippi Valley Railroad. The cost of such improvement was estimated in 1880 by Assistant Engineer Harrison, in his report to Major Benyaurd, at \$28,809, which, in comparison to the benefits to be obtained, is considered a very moderate sum.

To verify these estimates—under possibly changed conditions—I respectfully recommend that a survey be made as early in the spring as practicable, at a cost not to exceed \$500.

Very respectfully, your obedient servant,

J. W. BARLOW,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. B. B. SMITH, ASSISTANT ENGINEER.

NASHVILLE, TENN., *December 15, 1890.*

COLONEL: In accordance with your written instructions of December 8, 1890, I left Paducah, Ky., December 11, to make an examination of the Obion River, Tennessee, with a view of obtaining data for a report on the desirability and practicability of improving the river for navigation.

This river is formed by the junction of the North, South, Rutherford, Harris, and Big Davidson forks, near Crockett Station, on the Mobile and Ohio Railroad. Following a general southwesterly course through the counties of Obion and Dyer, it empties into the Mississippi River at Hales Point. The total length of the river is about 200 miles, but steamboats have never ascended it more than 85 miles, and its upper portion is but little used, even for rafting or flatboating. Following the general characteristics of the Mississippi River tributaries through this section, it flows through a low, alluvial country, with no rock to form serious shoals upon its course, is devoid of rapids, and for the most part deep and sluggish. Its average width is about 150 feet, and its depth will average 6 feet at low water, at least for the 85 miles below Obion Station, the only section navigated thus far by steamboats.

There are but two shoals on this lower section which obstruct navigation at extreme low stages. One of these is at Norman Mill, 35 miles above the river's mouth. It is a mud shoal, caused most probably by an accumulation of drift, and easily removed. The shoal does not continue for more than 1,500 feet, and at no time has less than 20 inches of water throughout its length. At Merriweather Ferry, about 55 miles from the mouth, is a mixed sand and gravel shoal. The river spreads here to about 300 feet in width, but the shoal is short, and always has 18 inches of water at lowest stages. These are the only points fordable for horses and cattle during dry seasons.

No work has been done upon the river by the General Government, though as far

back as 1842 the State of Tennessee appropriated quite a considerable sum for its improvement.

The river is very tortuous, Hales Point, at its mouth, being but 36 miles from Obion by land and about 85 miles by water. Flowing, as it does, through a heavily wooded country with timbered bottoms which are frequently overflowed and in which the lumbermen are constantly at work, its condition as regards snags and drift can be easily conjectured. The overhanging trees upon its banks for miles form dangerous obstructions to the upper works of steamboats navigating it.

During my visit to this section the river was entirely out of its bed, hence I could form no opinion as to the height and quality of its banks. Assistant Engineer Jeff Harrison's report to Maj. W. H. H. Benyard, in 1880, was shown to the several pilots and boat owners upon the river, and his statements of its general characteristics and obstructions were corroborated throughout. Most of my time was spent, therefore, in learning the general commercial status of the surrounding country.

The principal exports of the valley of the Obion River are lumber, wheat, and cattle. Its lumber interests are very large, the timber along the river bottoms being heavy and of a varied character. White and red oak, poplar, sassafras, cypress, hickory, beech, gum, cottonwood, ash, walnut, sycamore, and maple are all found in abundance and of a very fine quality. The farmers are turning their attention more and more to wheat, the land yielding good crops of an excellent quality. Cattle, sheep, hogs, mules, and horses are raised in abundance. But little tobacco is grown and less cotton seems to be planted, as the value of the country for wheat growing becomes more generally appreciated. Large quantities of corn are also grown, but this is mostly consumed at home.

The Newport News and Mississippi Valley Railroad controls all the freight interests of this section, and are not scrupulous in the use of their monopoly. The rates are simply exorbitant, and the farmer can only ship his products to such points as the road itself shall dictate. For instance, farmers consider Nashville as by far their best wheat market, but are unable to ship there, as the rates to Paducah Junction at the crossing of this road and the Nashville, Chattanooga and St. Louis Railroad, about 16 miles, are the same as they would be from this point to Nashville, a distance of about 150 miles. To further show their discrimination, the freight on a bale of cotton from Obion to Memphis is \$1.75, while from Dyersburg, but 22 miles farther south, it is but little over half that amount. The people living in the vicinity of the Obion claim that this difference is due to the fact that the Dyersburg people have a navigable river, the Forked Deer, and they have not.

Obion is the only town of any consequence upon this river, and is the main shipping point for the towns in the vicinity of the river, and for the farming and lumber interests upon its banks. Hornbeak, 9 miles from Obion and the same distance from the river; Glass, 3 miles, equally distant from railroad and river; Elbridge, 7 miles from Obion and but 3 from the river; Lane, 12 miles from Obion and directly on the river, and Minneck, 12 miles from Obion and but half that distance from the river, are all forced to haul by wagon to Obion as a shipping point. Each one of these towns is compelled to import all its supplies through Obion and the Newport News and Mississippi Valley Railroad.

The lumbermen of the district are compelled to haul their fine-grade, heavy lumber 12 and 15 miles to Obion. The river is considered entirely unsafe for barges, except at the very highest stages, when boats can safely pass over snags, which at low stages completely obstruct the navigation of the river. There are at present seven large sawmills on the river between Obion and its mouth with a joint capacity of 280,000 feet a day. The backbone of the country is in its lumber interests. For years millions of feet of lumber have been shipped from this district and yet the supply seems inexhaustible. The timber of the second bottom, being nearer to shipping points and more easily reached, is thinning out to some extent, but lumbermen in general state that the timber of the river bottom has hardly been touched as yet. Only the higher grades of lumber, quartered white oak, poplar, ash, and sassafras, have been largely shipped, the length of the haul warranting no shipment of the cheaper grades. The Stevens Lumber Company, of Dyersburg, is at present erecting a \$20,000 plant on the Obion River, 15 miles from its mouth, with a '10 years' cut in prospectus. All of the large firms in this district, of which there are several, state that the opening of the river to navigation would throw open millions of feet of the cheaper grades of lumber, and cause a large acreage to be cultivated which is now covered by the heavy timber, the density of the forest growth attesting to the richness of the land for agriculture.

Overflows of the bottoms have been of late years of more frequent occurrence, owing to the heavier accumulations of drift obstructing the free flow of the river. These bottoms are from 1 to 5 miles in width and are mostly of a soil and nature well adapted to agricultural purposes. The fact that they have not as yet been opened to any considerable extent is due to the total lack of transportation and therefore of incentives to culture.

No produce has been shipped from the river for several years. The water is generally low during harvest time, and the inhabitants can not afford to hold their produce till boats can ascend above the drift. Lane was at one time an important shipping point, from 400 to 500 bales of cotton, with other merchandise, being shipped yearly. The people are now compelled to haul to Dyersburg. Two steamboats navigate the river at high stages. Mill men at Dyersburg and at the mouth of the river agree in placing the output of lumber by water from the Obion River at not less than 50,000,000 feet, board measure, yearly. As this lumber goes to all points on the Mississippi River, and no record is kept, it is impossible to get any trustworthy data.

A glance at the index map * accompanying this report will show the extreme difficulty in separating commercial statistics of the counties adjacent to the Obion River and Forked Deer River. All of the country to the north of the Obion River and bordering on the southern portion of Reelfoot Lake ships through Obion. The statistics from this place are therefore definite. To the south of the river the inhabitants prefer to haul a longer distance to Dyersburg, and thus take advantage of cheaper rates of transportation.

Obion is a town of 800 inhabitants, with ten stores, and is the headquarters of three large lumber firms with joint sales of about 20,000,000 feet, board measure, of lumber yearly. Hornbeak, Elbridge, Dane, and Glass all have one or more general stores, but, as before stated, are entirely dependent upon the Newport News and Mississippi Valley Railroad as an agent for the shipment of imports and exports. Imports consist entirely of groceries and general supplies. Obion, with the country adjacent and dependent upon it for supplies, will be the chief place benefited by any improvement of the river. Dyersburg, on the Forked Deer River, a town of 2,000 inhabitants, is dependent for its flourishing condition to a great extent upon the produce and lumber of the southerly bottoms of the Obion. Five thousand bales of cotton are shipped yearly from this point, a large portion of the crop being raised in the Obion bottoms.

The following statistics are taken directly from the freight books of the Newport News and Mississippi Valley Railroad, and represent the shipments at the town of Obion for the calendar year of 1889, it being impossible to get, as yet, full returns for the year of 1890. These statistics will give a fair idea of the industry of the inhabitants of this section, and will, I think, establish their claim to a navigable river, with which to lower an exorbitant freight tariff:

Freight shipments on Newport News and Mississippi Valley Railroad, at Obion, Tenn., year of 1889.

Articles.	Quantity.	Value.
Wheat..... bushels..	60,000	\$80,000.00
Corn..... do.....	4,400	2,640.00
Stock..... head..	2,544	50,880.00
Hides..... pounds..	6,440	3,780.00
Shingles.....	1,050,000	10,500.00
Spokes, staves, and heading.....	10,000,000	100,000.00
Lumber..... feet..	18,801,245	376,024.90
Total.....		603,804.90

It will be remembered that much of the commerce of this valley goes through Trimble, Newman, and Dyersburg, all of them flourishing towns, but it is so mixed up with the commerce of a country in no way dependent upon the Obion River as to render statistics useless for our purpose. Obion is dependent entirely upon the Obion bottoms. The people of the country north of the Obion and along the lake are cut off from the Mississippi by impassable swamps.

Very respectfully submitted.

B. B. SMITH,
Assistant Engineer.

Lieut. Col. J. W. BARLOW,
Corps of Engineers.

* Not printed.

SURVEY OF OBION RIVER, TENNESSEE, FROM ITS MOUTH TO THE CROSSING OF THE LOUISVILLE AND MEMPHIS RAILROAD IN OBION COUNTY.

ENGINEER OFFICE, U. S. ARMY,
Nashville, Tenn., August 20, 1891.

GENERAL: I have the honor to transmit herewith a report with maps* of survey of Obion River, Tennessee, from its mouth to the crossing of the Louisville and Memphis Railroad in Obion County, to comply with the requirements of the river and harbor act of September 19, 1890, and the instructions of the Chief of Engineers dated December 20, 1890.

This river is a tributary of the Mississippi, rising in the western part of Tennessee, its navigable portion lying wholly in Obion and Dyer counties. It is formed by the junction of the North and South Forks, receiving their waters from numerous small tributaries, which drain a large area of territory, embracing Weakley, Gibson, Henry, and Carroll counties. In its course the Obion also receives the overflow from Reelfoot Lake, and near its mouth the waters of the Forked Deer River.

The charge of the survey of the river was intrusted to Mr. B. B. Smith, assistant engineer, who had previously made a preliminary examination of this river in December, 1890.

From this survey it is found that the Obion River, from the bridge of the Newport News and Mississippi Valley Railroad to the Mississippi, has a length of 68.8 miles and a fall of 27 feet. The course of the Obion is through a low, alluvial, and well-timbered country, subject to overflow, due in a great measure to backwater from the Mississippi. It has a width varying from 80 to 200 feet and a depth generally of over 5 feet at low water, except at certain shoals, where in some places a depth of but 18 inches was found. The shoals are usually caused by obstructing driftwood, which holds sediment in place, and it is thought that the removal of the drift will, in nearly all cases, cause the disappearance of the shoals.

In addition to the shoals and drift above mentioned the river is also obstructed by snags and overhanging trees.

No work has ever been done by the United States for the improvement of this stream, though in 1843 considerable work in clearing away obstructions was done by the State of Tennessee.

The tortuous course of the river is also a source of difficulty, some of the bends being very sharp, forming loops with narrow necks. At these points "cut-offs" could be made at small cost, nature having in some instances already begun the work.

The upper part of the river, from the railway crossing to Lane Ferry, a distance of 22 miles, has a depth of not less than $5\frac{1}{2}$ feet, and is only obstructed by snags and overhanging trees. Below Lane Ferry for a distance of 10 miles the river becomes more shallow, with an increased velocity of current. In this reach, 7 shoals were found having upon them a depth varying from 2 to $3\frac{1}{2}$ feet. Some of these shoals can be removed by taking out the imbedded drift, and others can be overcome by the construction of spur dams, causing a scour, the shoals in each case resulting from drift accumulations.

The only gravel deposit noted is at the "Ox Bow," 38 miles below Obion, where a considerable obstruction occurs. Here is found the shoalest water, it being from $1\frac{1}{2}$ to 3 feet deep, with a fall of 0.9 feet in a distance of 3,000 feet. It is thought this obstruction can be greatly

* Not printed.

improved by the construction of two spur dams and the closing of one of the two channels formed by an island.

Below this point is Campbell Island, where the obstructions can be overcome by closing one of the channels into which the river is divided by islands.

Grindstone Crank bend, 55 miles below Obion, is obstructed by drift and snags.

The section of the river 4 miles long, from Tiger Tail to the Mississippi, is also badly obstructed by snags, which require removal.

The principal obstructions noted are 5,111 trees, 1,072 snags, and 378 drift piles to be removed. Mr. Smith reports that owing to the back-water from the Mississippi at the time of the survey it is probable that many snags were overlooked in the lower reach of the river. The estimate for removing snags, therefore, should be greater than that given by him. The work enumerated is expected to provide a navigable width and a depth of not less than 3 feet at lowest stages.

The commerce of this river is principally lumber, cut by the seven sawmills now in operation on or near this stream. In connection with the above the following extract from the preliminary report is resubmitted:

Millmen at Dyersburg and at the mouth of the river agree in placing the output of lumber by water from the Obion River at not less than 50,000,000 feet, board measure, yearly. As this lumber goes to all points on the Mississippi river, and no record is kept, it is impossible to get any trustworthy data.

Two steamboats are now running on the river, another is being built, and a fourth contemplated.

Estimates in detail for the complete improvement of this river to secure a navigable channel not less than 3 feet deep at the lowest stages are given in Mr. Smith's report and amount to \$33,443, including plant for snagging and pile driving, or a cost of about \$500 per mile for the 68 miles under consideration. Taking into account the difficulties of carrying on work in a region remote from the source of supplies, and the probabilities of interference from high water, I should add 50 per cent. to Mr. Smith's estimate, making the probable cost of the improvement, in round numbers, \$50,000.

The Newport News and Mississippi Valley Railroad Bridge crossing this stream at Obion is an obstacle to navigation, and should the improvements as contemplated be undertaken, this bridge should be provided with a suitable draw.

Mr. Smith's report, together with a map* and profile* of the river, are transmitted herewith.

Respectfully submitted.

J. W. BARLOW,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. B. B. SMITH, ASSISTANT ENGINEER.

COLONEL: In accordance with your written instructions of May 20, 1891, I proceeded to Obion Station, on the Newport News and Mississippi Valley Railroad, on May 22, and began preparations the same day for making the survey of the Obion River. On May 26, the river being at ordinary low water throughout its entire

*Not printed.

length and not being affected by local rains, bench-marks were established simultaneously at Obion and Tiger Tail, 4 miles from the Mississippi River.

On May 29, everything being in readiness, the survey was started, the party consisting of 1 engineer, 1 leveler, 2 rodmen, a cook, and 3 laborers, being comfortably housed in a quarter boat.

A continuous transit and level line was carried throughout the entire length of the river. The zero for the transit line was taken just above the Newport News and Mississippi Valley Railroad Bridge; transit stations being numbered consecutively from 0 to 646. Distances were measured with the stadia. The average distance between stations was about 800 feet; the longest distance between stations being 1,400 feet; about 12 stations averaging 1 mile actual advance. The bench-mark for datum of levels was taken on the Newport News and Mississippi Valley Railroad Bridge, 18.7 feet above ordinary low water, an elevation of 100 feet being assumed. Two bench-marks were made each day and the fluctuations of the river carefully noted.

Soundings greater than 7½ feet were not recorded; depth being examined by continuously thrusting a 7½-foot paddle its full length into the river. Whenever the paddle reached bottom, which seldom occurred, a more exact examination was made, shoals being carefully examined and their extent noted. All overhanging trees obstructing present or likely to obstruct future navigation were carefully counted. All snags were noted, as also obstructions caused by drift accumulated above trees which had fallen into the channel of the river.

The first 46 miles of the survey were made under most favorable conditions, the river being at an ordinary low-water stage, a 2-foot rise with a speedy fall being of small inconvenience. Below this for a distance of 22.8 miles it was impossible to see all obstructions or to get definite information as to the condition of the channel, owing to a heavy rise in the Mississippi River, the backwater filling the Obion banks full. Such information, however, as could be obtained from raftmen and millmen along the route was carefully gleaned.

The survey occupied 20 working days and was brought to a conclusion on the afternoon of June 19 at a point 1 mile above Hale Point, the junction of the Obion River with the Mississippi River.

The instruments used were a Gunley transit, reading to 30 seconds, and a Stackpole level, the adjustment to both instruments being frequently examined and carefully corrected.

The Obion River is formed by the junction of the North, South, Rutherford, and Harris forks, near Crockett, on the Mobile and Ohio Railroad. From this point it follows a generally southwestern course, emptying into the Mississippi River 1 mile above Hale Point. The river has been navigated only as far as Obion Station, and improvement would be practicable only to the junction of the North and South forks, 6 miles above this point. The distance from Crockett to Obion does not exceed 30 miles, the measured distance from Obion to the mouth being 68.8 miles. The total fall in the 68.8 miles is 27 feet.

The country through which the Obion flows is a low, level, alluvial district, subject to overflows both from the Obion itself and the backwaters from the Mississippi, which reach as high as Crockett at extreme stages.

No work has ever been done on the river by the General Government. As far back as 1843 surveys were made by the State of Tennessee and considerable work done by the State in clearing the river of obstructions.

The Obion River varies from 80 to 200 feet in width at low stages. The banks are from 10 to 18 feet above low water. But little water erosion is noticeable anywhere, the lower parts of the bank being a stiff white clay, the higher alluvial portions being protected from wash by the heavy timber which reached everywhere to the water's edge.

Though somewhat tortuous, especially in its upper portions, it is believed that small boats with tows would have little difficulty making the worst bends, there being but little current to contend with and the river being generally wider at these points.

There are three points where "bends" could be cut off to advantage, only two of them, however, being practicable, the fall on what is known as the "Ox Bow" being too great to warrant such improvement. The first "cut-off," 5½ miles below Obion, is 1½ miles around and but 650 feet across, the fall in this distance being .56 feet. The river is already cutting its way through, water flowing freely even at lowest stages. The second "cut-off," Starett Bend, 8½ miles below Obion, is 1 mile around and but 1,000 feet across, with a fall of 1 foot in this distance. A "cut-off" has been started here by raftmen, simply by deadening the timber; though the fall is considerable, it is believed it would be most advantageous to make this the permanent channel, as the old channel is exceedingly rough and tortuous and at present absolutely unfit for navigation. These cut-offs can be widened and deepened by cutting and grubbing timber and shutting off the old channel by means of pile and brush dams. The Ox Bow, 38 miles below Obion, is 1 mile around and 1,100 feet across, with a fall of 2

feet in this distance, the amount of fall, as before stated, rendering a cut-off undesirable.

From Obion Station to Lane Ferry, a distance of 22 miles, the river, though considerably obstructed by snags and drifts, is exceedingly deep. The shallowest water found was 5½ feet, just below the mouth of Mill Creek. No improvement other than snagging and clearing of overhanging trees is deemed necessary on this portion of the river. From Lane Ferry for a distance of 10 miles, the hills which surround the bottoms a distance varying from 1 to 3 miles from the river, approach the banks, skirting them in many places. The river narrows considerably at these points, growing shallow and swift, with an increased fall of the water surface, though the fall is small in all cases. Seven shoal places were noted on this section mostly sand and drift shoals, varying in depth from 2 to 3½ feet and not exceeding 300 feet in length. These shoals I have numbered from 1 to 7 inclusive. Numbers 1, 3, and 4 can be improved by the building of short spur dams from the left shore and the removal of drift and logs, which have become imbedded in the river channel. Numbers 2, 5, 6, and 7, it is believed, will correct themselves after the imbedded logs and drift piles have been removed. The fall in these shoals does not exceed .3 foot in 1,000 feet, all of them being caused by the accumulation of drift and a consequent sand deposit.

In the "Ox Bow," a shoal known as "Gravelly Bar" forms quite an obstruction to navigation. It is notable as the only gravel deposit in the river. The river widens here to something over 200 feet. The river bottom is very level, with from 1½ to 3 feet of water at lowest stages, and a fall of 0.9 foot in 3,000 feet. In one place two small towheads divide the channel. Two spurdams and another closing one of the channels around the towheads, it is believed will correct this obstruction.

Just below this obstruction Campbell Islands again widen and divide the river channel. A dam shutting off one of these channels will give over 3 feet of water to navigation at all stages.

Below these obstructions a bad bend, known as the "Grindstone Crank," which is narrow and obstructed by drifts and snags, and the 4 miles of river from Tiger Tail to the Mississippi, are the only bad portions. These can be corrected by the careful removal of drifts and imbedded logs which cause shoal places in an otherwise deep channel.

The work as described above will give a 3-foot channel throughout the 68.8 miles of river at lowest stages.

We counted on the survey 5,111 trees obstructing or about to obstruct navigation, and 1,072 snags and 378 drift piles caused by accumulation of floating drift above trees which had fallen into the river. The snags which will have to be removed are far in excess of the number counted, as very many that could not be seen are said to obstruct the last 22 miles of the river, being rendered invisible by the backwaters from the Mississippi River. The trees counted were mostly water birch, with a sprinkling of willow and cottonwood. These trees when felled should be cut up and burned or floated out of the river.

Seven sawmills with a joint daily capacity of 104,000 feet B. M., are in constant operation on or near the river, notably Hester's Mill, capacity 15,000 to 20,000 feet; Stull's Mill, 15,000 to 20,000 feet; William's Mill, 8,000 to 10,000 feet; Fleischauer's Mill, 15,000 to 25,000 feet; McCorele's Mill, 20,000 feet; Scott's Mill, 30,000 to 40,000 feet; and Tiger Tail Mill, 20,000 to 30,000 feet. These mills all depend more or less on the river for transportation, and would use it altogether were it fully opened to navigation.

Two steamboats ply on the river, the property of Mr. Hall, of Dyersburg, and the Stevens Lumber Company, of the same place. Mr. Fleischauer, a mill owner on the river, is already building a third boat, and Mr. Hall has signified his intention of putting a packet on the river if operations for improvement are begun.

The Newport News and Mississippi Valley Railroad has twice in the past 6 months increased an already exorbitant freight rate, and the people of a flourishing community are clamoring loudly for some relief. The country immediately bordering on the river is uncleared and covered with fine forests of native timber of all varieties indigenous to the country. Beyond these bottoms, sometimes skirting the river banks, is one continuous stretch of fine and highly cultivated farm land.

For statistics I would respectfully refer you to my report of December 15, 1890, it being impossible to obtain fuller or more definite statistics, as no regular commerce reports are kept.

The estimate for improvement based on the survey is as follows:

<i>Plant.</i>	
Steam snag and pile driver boat	\$2,500.00
Quarter boat	600.00
Two barges	600.00
Outfit, rope, axes, etc.	500.00
	<hr/> 4,200.00

2300 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Force for snag boat—6 months' estimates for clearing channel.

Assistant engineer	\$150.00
Overseer	75.00
Engineer	60.00
Fireman	40.00
Cook and helper	60.00
Laborers, 10	300.00
Subsistence	160.00
	<hr/>
Contingencies, 20 per cent.	845.00
	169.00
	<hr/>
Total (per month)	1,014.00
For 6 months, total	6,084.00
Clearing river banks of heavy timber 50 feet each side for 70 miles, 815 acres, at \$15 per acre	12,750.00

Opening "cut-offs" to navigation.

First cut-off:	
Clearing and grubbing 100 feet in width, 650 feet long	150.00
Building pile dam 150 feet long:	
225 driven piles, at \$3	675.00
70 cords of brush, at 80 cents	56.00
160 yards clay or sand, at 50 cents	75.00
	<hr/>
	956.00
Starrett Bend Cut-off:	
Clearing and removing stumps, 100 feet wide, 1,500 long	300.00
Building dams same as at first cut-off	806.00
	<hr/>
	1,106.00

Improving shoals.

Bar No. 1, 1,500 feet long:	
1 wing dam, 50 feet long	200.00
Scraping and removing sunken snags, etc	300.00
	<hr/>
	500.00
	<hr/>
Bar No 2:	
Dredging and removing sunken logs, 300 feet	300.00
	<hr/>
Bar No 3:	
Wing dam, 300 feet long	150.00
Removing drift and scraping	200.00
	<hr/>
	350.00
	<hr/>
Bar No. 4:	
Wing dam	200.00
Clearing drift, etc	200.00
	<hr/>
	400.00
	<hr/>
Gravelly Bar:	
3 wing dams:	
230 driven piles, at \$3	690.00
48 cords of brush, at 80 cents	38.80
60 yards sand, at 50 cents	30.00
	<hr/>
	758.80
	<hr/>
Campbell Islands:	
Wing dam	500.00
Grindstone crank:	
Removing sunken logs, scraping, etc	500.00
	<hr/>
Tiger Tail to mouth of river:	
General improvement	2,000.00

Totals.

Plant	\$4,200.00
Snagging	6,084.00
Clearing, etc.	12,750.00
General improvement	7,368.80
	<hr/>
	30,402.80
Contingencies, 10 per cent.....	3,040.28
	<hr/>
	33,443.08

The only suitable place for a harbor and landing at Obion is about 2,000 feet above the Newport News and Mississippi Valley Railroad Bridge. The river at this point is 160 feet wide, exceedingly deep, and with a gently sloping bank most suitable for a landing place. The bridge of the above railroad is a pile bridge, and forms an absolute obstruction to navigation. If the river be improved this bridge should be changed to a drawbridge in the interests of navigation.

With this report are presented a continuous map of the river on 5 sheets, drawn to a scale of 1,000 feet to 1 inch, and a profile showing a depth of channel, height of bank, and slope of river.

Respectfully submitted.

B. B. SMITH,
Assistant Engineer.

Lieut. Col. J. W. BARLOW,
Corps of Engineers, U. S. A.

APPENDIX F F.

IMPROVEMENT OF TENNESSEE RIVER BETWEEN CHATTANOOGA, TENNESSEE, AND FOOT OF BEE TREE SHOALS, ALABAMA.

REPORT OF LIEUTENANT GEO. W. GOETHALS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER DOCUMENTS RELATING TO THE WORK.

IMPROVEMENTS.

- | | |
|--|--|
| 1. Tennessee River between Chattanooga, Tennessee, and foot of Bee Tree Shoals, Alabama. | 2. Operating and care of Muscle Shoals Canal, Tennessee River. |
|--|--|

EXAMINATION.

3. Mouth of Gunter Creek at Guntersville, Ala., with the view of ascertaining the practicability and approximate cost of so improving the same as to secure a safe landing above high-water mark.
-

ENGINEER OFFICE, U. S. ARMY,
Florence, Ala., July 8, 1891.

GENERAL: I have the honor to transmit herewith annual reports for the works of improvement in my charge, for the fiscal year ending June 30, 1891.

Very respectfully, your obedient servant,

GEO. W. GOETHALS,

• *First. Lieut., Corps of Engineers.*

Brig. Gen. THOMAS L. CASEY,

Chief of Engineers U. S. A.

F F 1.

IMPROVEMENT OF TENNESSEE RIVER BETWEEN CHATTANOOGA, TENNESSEE, AND FOOT OF BEE TREE SHOALS, ALABAMA (260 MILES).

The report on this portion of the river is subdivided to agree with the allotments of the appropriation for improving Tennessee River, below Chattanooga, Tenn., act of September 19, 1890, as follows:

1. Chattanooga, Tenn., to Decatur, Ala. (180 miles).
2. Decatur, Ala., to Florence, Ala. (50 miles).
3. Florence, Ala., to the foot of Bee Tree Shoals (30 miles).

1. CHATTANOOGA, TENNESSEE, TO DECATUR, ALABAMA.

The most serious obstructions in this section of the river are "The Suck," the bars near Bridgeport, Ala., and the Guntersville Bar.

"*The Suck*" is the name commonly applied to the several rapids and shoals where the river winds in a tortuous route through the mountains below Chattanooga, covering a distance of $8\frac{1}{2}$ miles, in which the fall is $16\frac{1}{2}$ feet. The obstructions, separated by pools, are known as Tumbling Shoals, the Suck, the Pot, the Skillet, and the Pan, and are formed by rock reefs and bowlders and by protruding rocky points from both shores, which contract the water way. At medium and low-water stages Tumbling Shoals, the Suck, and the Skillet are especially difficult to navigate, while the Pot and the Pan, easily passed during low water, are dangerous obstructions at high stages.

The channel work carried on in 1869 and 1870 at the Suck and the Pot, and in 1889 at the Pan, consisting in the removal of bowlders, projecting rocky points, and overhanging trees, has resulted in somewhat diminishing the velocity of the current, but upstream navigation is still attended with delays caused by the necessity of laying lines and warping vessels over the swiftest places.

Bridgeport Bars.—There are three bars in the vicinity of Bridgeport, any one of which is an obstruction to low-water navigation. They consist mainly of rock reefs covered with gravel and bowlders. One is above the railroad bridge, another at the foot of Bridgeport Island, and a third, known as Widow Bar, is about $1\frac{1}{2}$ miles below the island.

Guntersville Bar.—The river just above Guntersville is obstructed by bowlders and loose, detached rock, which make the steamboat channel very crooked and difficult of passage during low-water stages.

The Board of Engineer Officers convened by Special Orders, No. 83, 1889, Headquarters Corps of Engineers, in their report of October 22, 1890, approved October 25, 1890, allotted \$50,000—

to the river between Chattanooga, Tenn., and Decatur, Ala., to be expended in removing bowlders by blasting, cutting trees from the banks, and dredging at and between the localities known as Tumbling Shoals, Suck, Pot, and Skillet, in the mountains below Chattanooga, as proposed in the report of Board of this date, and in channel excavation at Bridgeport and Guntersville, Ala.

Nothing was done in this section of the river until after the last high water. In the latter part of April a party was organized to make detailed surveys of these localities, to determine water slopes, depths at low water, character of bottom, width of water way, discharge, etc., at The Suck, and to procure sufficient data at Bridgeport and Guntersville to determine character and amount of excavation required.

Field work was commenced in May and transit and level lines carried down to Suck Point, a distance of about 12 miles. Four gauges were established through "The Suck," and permanent bench-marks located to assist in locating cross sections for discharges at various water stages. High water, caused by frequent and heavy rains during June, has materially retarded the progress of the work.

Of the amount allotted for this section of the river, \$2,519.24 have been expended in procuring the necessary instruments, boats, etc., and in prosecuting the work.

2. DECATUR, ALABAMA, TO FLORENCE, ALABAMA.

The principal obstructions are the Muscle Shoals, extending from deep water at Browns Ferry to deep water at Florence, a distance of 38

miles, only 8 of which are navigable, and embracing Elk River Shoals, Big Muscle and Little Muscle Shoals.

The object of the improvement is to make continuous navigation around these obstructions by means of a lateral canal.

The approved project, according to which work is being done, based upon the survey of 1872, and somewhat modified in 1877, is:

(1) To enlarge, rebuild, and straighten the old canal around Big Muscle Shoals built by the State of Alabama in 1831-'36, and abandoned in 1837, by constructing a canal $14\frac{1}{2}$ miles long, having nine locks, with a total lift of 85 feet, and an aqueduct 900 feet long and 60 feet wide over Shoal Creek, with the necessary permanent dams and bridges over the several creeks and ravines; the canal trunk to be from 70 to 120 feet wide at the water surface and 6 feet deep, and the locks 300 feet long, 60 feet wide, and having a depth of 5 feet of water on the miter sills.

(2) To construct at Elk River Shoals a canal $1\frac{1}{2}$ miles long, with two locks, having lifts of 12 feet and from 5 to 9 feet, respectively, and of same dimensions as the locks at Big Muscle Shoals.

(3) To blast at Little Muscle Shoals a channel through the bed-rock of the river, and to construct stone wing dams and retaining walls to contract the waterway and to check the velocity of the current at certain points.

Having finished the necessary repairs and detailed work required to properly operate it, the canal was filled with water throughout its entire length on November 8, and opened to navigation November 10, 1890.

Elk River Division.—During the past fiscal year the construction of a drift sluice in the longitudinal dam from Browns Island to Lock A was commenced, and is well under way. The opening is 40 feet in the clear, closed by the Parker automatic gate, a modification of the bear trap; the difference of reference of its crest when up and down is 8 feet. It is hoped by this means to keep the basin above Lock A free from drift, which collects in such quantities during high water as to materially interfere with navigation.

The filling on both sides of Lock A to the level of the top of the lock walls was completed; the slope on the river side was covered with heavy riprap to protect it against wash during high water. An office was built on the south side of the lock.

Work in the channel below Lock B consisted in dredging out the remains of the old cofferdam, removing bowlders and detached rock from Gilchrist Chute and Nance Reef, and has resulted in straightening and deepening the channel. A detailed survey was made from Lock B to Lock 1 to ascertain the condition of this portion of the river, and to enable the preparation of a project for its radical improvement. Land was purchased at Locks A and B as sites for lock keepers' houses.

Muscle Shoals Division.—During the fiscal year the following work has been done on this division:

The dam across Second Creek was extended 30 feet, a new abutment built, and another span added to the bridge over the dam. This extension replaces a part of embankment built around the abutment of the old State dam at this locality, which was a constant source of expense, due to frequent breaks and washouts; the spill is also increased, an advantage during high floods.

Trussed fenders, consisting of Howe trusses 2.5 feet between outer surfaces of chords, were built on both sides of the aqueduct along its entire length; the object of these is to increase the resistance of the sides against the concussion of striking boats, and to distribute such shocks to a greater number of piers.

The work of blasting off the bluffs below Lock 7 was continued until November 8, resulting in an increase of 30 feet in the width of the canal at this locality. The riprap stone thus obtained was placed along the outside of the towpath between Locks 7 and 8 to strengthen it, and the spalls, added to clay, were placed along the interior slope to stop leaks.

Steel miter gears were put on the shafts of the drop gates to replace the cast-iron ones at first used, as the latter did not possess the requisite strength; 12 small casks were put on each drop gate to increase its buoyancy, and brakes were added to the maneuvering apparatus to control the motion of the gates.

About 9,000 cubic yards of sediment, that had been deposited in the various levels by the creeks and small branches flowing into the canal, were removed, partly by hand and partly by the dredge *Harwood*, reducing the bottoms to proper grade.

The remains of the old cofferdam below Lock 9 were also removed.

The work of rebuilding the railway along the towpath was begun and about 9.5 miles completed. The track is well ballasted with broken stone throughout, and a new 40-pound steel rail is used on the side nearest the canal.

A quarry was opened on the Government land at Lock 4 to obtain riprap stone for paving the inner slope of the canal embankment, which is washing away by waves from passing boats; about 5,336 cubic yards are ready for this purpose. The slope must be protected by broken stone before paving, as it is found that the waves wash out the earth behind dry walls, leaving the latter unsupported.

Land for sites for lock masters' houses was purchased at locks 3, 4, and 6, and negotiations are now under way for buying the requisite land at locks 5 and 9. Lock master's house at Lock 1 is completed, except painting. The house for the assistant engineer at Lock 6 is finished, except the plumbing. Foundations for lock masters' houses at locks 3 and 6 are completed, and at Lock 4 well under way. An assistant lock master's house was built at Lock 7.

A Bucyrus dredge is being built under contract for use at the canal.

For details of work done on both divisions of the canal attention is invited to accompanying report of Mr. W. A. McFarland, assistant engineer.

Little Muscle Shoals.—The improvement under the modified project, as above, has been practically completed, by cutting a channel $2\frac{1}{2}$ miles long through the bed-rock and building some 3 miles of riprap wing-dams. The results obtained are not satisfactory, and a report to this effect having been submitted by Lieut. Col. J. W. Barlow, Corps of Engineers, the question was referred by the Chief of Engineers to a Board of Engineer Officers for consideration.

The Board constituted by Special Orders No. 83, Headquarters, Corps of Engineers, December 16, 1889, in their report of October 23, 1890, and approved under date of October 29, 1890, recommended the construction of a lateral canal on the north bank, 15,000 feet long, with one lock of the same size as those of the Big Muscle Shoals Canal; that is, 60 feet by 300 feet, with a lift of 12 feet, and guard lock at head of the canal.

No work was done in this locality during the past fiscal year.

On recommendation of the Board \$250,000 were allotted from the appropriation of September 19, 1890, for continuing improvement at Muscle Shoals Canal. During the fiscal year \$152,263.25 were expended.

REPORT OF MR. W. A. MCFARLAND, ASSISTANT ENGINEER.

SUMMARY OF WORK DONE ON THE TWO DIVISIONS OF THE MUSCLE SHOALS CANAL DURING THE FISCAL YEAR ENDING JUNE 30, 1891.

(1) *Above Lock A.*—At the Bluff Quarry 540 cubic yards of stone were quarried for the dam, and 101 cubic yards for use in building the drift sluice; 142 cubic yards of earth were stripped from the quarry.

Repairing dam.—One hundred cubic yards of stone were used in closing an opening in the dam opposite Miltons Bluff, and 145 cubic yards in repairing leaks where the dam crosses towheads. One thousand and forty-six cubic yards of dredged material from below Lock B were deposited along the back of the dam for a distance of about 800 feet, to close leaks.

Drift sluice.—In November, 1890, the building of a drift sluice, 40 feet wide, to carry off floating drift from the canal to the river, was begun. Owing to high water in the river, work was suspended from January to May, 1891. The sluiceway when not in use is to be closed by a "Parker patent gate." A cofferdam of sheet piling and clay puddle was built, having a canal face 90 feet, with arms of about 30 feet connecting with the rock-fill dam which forms the canal embankment at this point; 902 cubic yards of clay puddle were used in filling in and around this cofferdam, the greater part of the material being obtained from the vicinity of the Bluff Quarry. A second and smaller cofferdam, built of earth only, was put on the river side of the sluice site; 303 cubic yards of earth were used.

Material was excavated as follows:

	Cubic yards.
Earth.....	500
Rock.....	68
Mud, loose rock, and stumps.....	775
Snags pulled.....	24

Of this amount 34 cubic yards of rock were used as backing to strengthen the main cofferdam; 440 cubic yards of clay were used as backing to the rock-fill dam in the immediate neighborhood of the cofferdam. A centrifugal pump run by a small stationary engine was used to keep the excavation free from water.

Present condition of the work.—The bottom timbers of the sluiceway are in position, the wall of masonry and timber at the east side is completed and the west wall nearly so, and all timber and iron for the completion of the gate are ready for framing. Timber to the amount of 15,047 feet, B. M., has been framed and put in position, and 150 cubic yards of masonry laid, leaving only 32 cubic yards of masonry to complete this part of the work.

Retaining wall on crib above Lock A.—This wall was built up to a height of 4 feet 6 inches from the crib foundation for a length of 40 feet, and the remainder of the wall, about 80 feet in length, was increased in height from 3 feet 4 inches to 4 feet 6 inches. Six cubic yards of stone were cut for this work, and 15 cubic yards laid in cement mortar.

Miscellaneous.—Fifty-one cords of drift wood were taken from the dam and used as fuel at Miltons Bluff.

The construction track along the dam was extended from just above Lock A up the canal for a distance of about 800 feet, and was used in distributing along the back of the dam the material which had been received from below Lock B.

Two hundred and nine rails, 12 kegs of track bolts, and 244 fish plates, which had been lost in the river just below Decatur, were recovered.

(2) *At Lock A.*—Filling: Three thousand three hundred and seventy cubic yards of dredged material from below Lock B were used in filling in back of the north wall of the lock. Two thousand, three hundred and thirty-four cubic yards of earth and 80 cubic yards of rock were used as filling on the south side of the lock, most of the material being wheeled from the bottom of the canal just below. Grading and leveling north of lock, 125 cubic yards.

Hydraulic machinery.—The pump-house was raised 2 feet, turbine and pumps removed and replaced 2 feet lower to give greater head of water, and the flume to the turbine lowered 2 feet 6 inches and widened 3 feet 6 inches; present size of flume 6 feet wide and 8 feet high. Sixteen 3-way cocks on the gate engines were replaced by eight 4-way cocks.

Sluiceway south of lock.—Seventy-three and one-half cubic yards of dry wall laid. This sluiceway was abandoned, the stone and timber removed, and the trench refilled. Four hundred and forty-five cubic yards of stone taken from this place were used in part for the retaining wall on the opposite side of the canal, and in part as riprap.

Office.—A frame building, 18 by 34 feet and two stories in height, was built on the south side of the lock, and is used as an office and temporarily as a residence by the lock-master.

Three acres of land were cleared of timber and underbrush as a site for lock-master's house.

(3) *Between Locks A and B.*—One hundred and forty cubic yards of riprap, to save the canal embankment from wash by the river during high water, were placed on the outer slope, extending from a point 50 feet above the pump-house, westward for a distance of about 800 feet. This stone was taken from the Bluff Quarry.

(4) *At Lock B.*—Grading on north side of lock, 143 cubic yards.

(5) *Below Lock B.*—Dredging: Sixteen thousand four hundred and forty-six cubic yards of mud, sand, gravel, small stones, and boulders were removed by dredge *Harwood* from the channel immediately below Lock B to Gilchrist Chute. Of this amount 9,940 cubic yards were deposited near the left bank, the remainder being used, as stated above, in repairing dam and in grading at locks.

Removing rock at Nance Reef.—One hundred and sixty-nine cubic yards of material, consisting of boulders and fragments of rock previously blasted, were removed from the chute at Nance Reef and deposited as a guide dam to the chute.

Miscellaneous.—Drift: It is estimated that 1,655 cords of drift wood were locked through the canal during the year. Great inconvenience is caused by this drift, which collects in large quantities above Lock A, and seriously interferes with navigation.

One and one-half miles of railway track, from below Lock A to above Lock B were taken up.

Above Lock 1.—At the upper entrance to the canal, about a half mile above Lock 1, 7,760 cubic yards of mud which had collected in the channel was dredged out by the United States dredge *Harwood*. The greater part of this material was carried out into the river by the current passing through a cut near the shore end of the wing dam, and the remainder was deposited on shore and in shoal water to the north of the channel.

At Lock 1.—The lock-master's house was completed with the exception of painting. Work was done as follows: Three chimneys built, 400 square yards of plastering, 18 windows cased and finished, 15 doors fitted and hung, 11 doors cased, 1,230 feet of flooring laid, stairs and west gable finished, 2 hearths put in, mantels set, and broken windows reglazed.

Twenty cubic yards of mud, which had collected about the miter sills of the lock, and which interfered with the movements of the gates, were removed by hand-dredging, the steam dredge being unable to work in so contracted a space.

Between Locks 1 and 2.—A new span 30 feet in length was added at the upper end of the Second Creek Dam and Bridge, to overcome a weak place in the embankment caused by the remains of an old abutment, and also to increase the capacity of the dam for carrying off the surplus water from Second Creek in time of freshet. A cofferdam of sheet piling and clay puddle was built to exclude the water of the canal; 420 cubic yards of earth and 24 cubic yards of old masonry were excavated, and 168 cubic yards of masonry laid in cement mortar. Nine cubic yards of cut stone were used for coping, etc. Two new 15-inch I-beams were used on the bridge span. This work is complete with the exception of removing the cofferdam.

At Lock 2.—The veranda of the assistant lock-master's house was moved from the front to the end, this being necessary to give sufficient room for railway construction at this point.

Between Locks 2 and 3.—Two hundred and fifty-five cubic yards of rock, gravel, etc., which had become detached from the bluffs by the action of frosts and fallen into the canal, were removed; the pool was emptied and the work of removal done by hand. One thousand five hundred and sixty-nine cubic yards of clay were used in stopping leaks and strengthening embankments.

At Lock 3.—The foundation wall and piers for the lock-master's house were completed, 27 cubic yards of earth being excavated, and 21 cubic yards of masonry laid; the foundation is now ready for the superstructure.

Between Locks 3 and 4.—Four of the valves in Bluewater Dam being in bad condition were removed and replaced by new and stronger ones. Ninety-eight cubic yards of rock which had fallen into the canal from the bluffs were removed. Two hundred and thirty cubic yards of riprap were placed on the outside of the embankment.

Lock 4.—A quarry camp was established at this lock, and a quarry opened on land belonging to the United States, for the purpose of getting stone to be used in paving the inner slope of the canal embankment, and in ballasting the railway; up to the end of the fiscal year 7,336 cubic yards of stone had been quarried and 6,611 cubic yards of earth stripped from quarry; of the stone quarried 2,000 cubic yards were used in ballasting railway. About June 1 a stone-crusher was received at the quarry and mounted on a barge for convenience in handling; this plant has since been used in preparing stone for use on railway, 821 cubic yards being crushed.

Twenty cubic yards of earth excavated for foundation of lock-master's house and 5 yards masonry laid.

Between Locks 4 and 5.—Twenty-five cubic yards of riprap stone were used in strengthening the embankment.

At Lock 5.—Brakes, walk way, and floats were attached to the drop gate, and the cast-iron miter gears connecting vertical with horizontal shafts were replaced by cast steel. One thousand and fifty-one cubic yards of earth and 11 cubic yards of broken stone were used in filling in on the north side of the lock, giving an embankment about 15 feet in width at top.

Between Locks 5 and 6.—In the vicinity of Four-Mile Creek, the pool being empty, a branch track 500 feet long was laid from the railway to the bottom of the canal, and 5,350 cubic yards of earth were removed from above grade. Four hundred and ninety-eight cubic yards of heavy riprap stone were taken from Brook's Quarry and placed on the outer slope of the embankment just below Six-Mile Creek. To do this work to advantage a steam derrick was erected on a barge.

Two maneuvering gears for opening and closing valves were put in at Six-Mile Dam.

At Lock 6.—Floats and brakes were attached to the drop gate, and cast-iron bevel gears replaced by steel. Work was done on the assistant engineer's house as follows: 33,650 brick laid; 1,986 square yards plastering (two coats), 465 square yards lathing; 360 feet flooring laid; 300 feet ceiling put in front hall; front stairway built complete; front and side verandas built; fireplace built in front hall, and five hearths and mantels put in; doors and windows cased and finished, and painting complete inside and out. The house is now finished, with exception of plumbing.

Foundation wall and piers for the lock-master's house were completed, 25 cubic yards of earth being excavated and 21 cubic yards of masonry laid; the foundation is ready for the superstructure.

There were also built a house for the shelter of lime and cement, a temporary shelter for locomotive, and a fence around the United States land on the north side of the canal. A short wall of dry rubble was built on the inner slope of the embankment immediately below the lock to protect embankment against wash during emptying of lock.

Between Locks 6 and 7.—One hundred and forty-two cubic yards of earth and gravel deposit were removed from the bottom of the canal.

Aqueduct.—A timber fender guard was built on either side of the aqueduct along its whole length, with the object of lessening the shock in case of collision with the structure by passing craft.

New valves and valve-gear were put in just above and below the aqueduct, and accumulations of drift were cleared away from against the upper sides of its piers.

At Lock 7.—Brakes and floats were put on drop gate, and a broken pinion was removed from the horizontal shaft and replaced by a new one. Cast-iron miter gears were replaced by steel. Thirty-five hundred and seventy-one cubic yards of earth and 540 cubic yards of broken stone were used in filling in back of the lock wall on the north side, giving a fill 15 feet wide on top, with slopes of about 45 degrees.

A house for the assistant lock master was built on the south side of the lock.

Between Locks 7 and 8.—Four thousand five hundred and eighty-two cubic yards of rock were quarried from the bluffs on the north side of the canal just below Lock 7, and 4,216 cubic yards of this amount was placed as riprap on the outer slope of the embankment on the same section. The spalls obtained in the course of the work were used as pavement on the inner slope of the embankment. As a result of this rock excavation the available width of the canal at the bend just below Lock 7 was increased by 30 feet. Three hundred and ninety-three cubic yards of clay were used in stopping leaks.

At Lock 8.—Brakes and floats were put on the drop gate; cast-iron miter-gears replaced by steel, and the plank walk-way along the north side of the lock was completed.

At Lock 9.—Brakes and floats were put on drop gate, and cast-iron miter-gears replaced by steel.

Below Lock 9.—One thousand two hundred cubic yards of sand and gravel were dredged from the entrance to the canal and thrown over into deep water in the river by the United States Dredge *Harwood*, and an old cofferdam which had been an obstruction at low water was removed.

Railway construction.—On January 5 the work of rebuilding the railway along the canal towpath was begun, and up to July 1 a length of 50,500 feet had been completed. The track is laid on ties of white and post oak, and is ballasted with broken stone throughout. A new 40-pound steel rail is used on the side of the track nearest the canal, the other side being made up of the best of the rails from the old track. Two new 18-ton locomotives were received during the year, and one of them has been in constant use for several months.

The steamer *McFarland* has been employed in towing and assisting in the general work on the canal.

Miscellaneous.—The telephone line has been extended to Locks 7 and 8. A derrick

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was built on a barge for the use of the United States snag boat *Weitzel*. Weeds and brush were cut along the banks of the canal for a distance of 14 miles and from the bottom for a distance of about 5 miles. About 200 muskrat holes were dug out and refilled. Up to April almost constant repairs were made to the old railway, as in spite of its bad condition it was in constant use. The following table will show at a glance the total amount of excavation, etc., done during the year:

[Quantities given in cubic yards.]

Location.	Excavation.				Fill.			Quarry.		Stone crushed.	Masonry laid.	Stone cut.
	Dredging.	Earth.	Loose stone.	Rock.	Earth.	Loose stone.	Riprap.	Stone.	Earth stripped.			
Above Lock A		1,275		68	2,691		279	641	142		*185	6
At Lock A				445	5,704						73	
Between A and B		2,334					140					
Below Lock B	16,446			169								
Above Lock 1	7,750											
At Lock 1	20											
Between 1 and 2		420	24								168	
Between 2 and 3			255		1,569							
At Lock 3		27									21	
Between 3 and 4			98				230					
At Lock 4		20						7,336	6,611	821	5	
Between 4 and 5							25					
At Lock 5					1,051	11						
Between 5 and 6		5,350					498					13
At Lock 6		25									21	
Between 6 and 7		142										
At Lock 7					8,571	540						
Between 7 and 8				4,582	393		4,216					
Below Lock 9	1,200											
Total	25,416	9,593	377	5,264	14,979	551	5,388	7,977	6,753	821	453	19

* Dry rubble.

3. FLORENCE, ALABAMA, TO THE FOOT OF BEE TREE SHOALS.

Colbert and Bee Tree Shoals, beginning about 22 miles below Florence, form the principal obstructions to navigation during the low-water stages. These shoals, which may be considered as forming one continuous obstacle, are 8 miles in length, with a total fall of 25 feet at low water, and at this stage the depth in the channel is about 1.5 feet. Four islands divide the river through the shoals longitudinally, and the work heretofore carried on for the improvement of navigation consisted in building riprap dams, which, in connection with the islands, confined the water to the chute along the north bank. Increased depth was obtained by channel excavation. This method does not give results adequate to the present needs of commerce.

Surveys were made in August and September, 1890, to procure such additional information as was required to prepare a project and estimate for the radical improvement of the shoals. These surveys, at first confined to the islands and the chute to the south, were subsequently extended over the bottom lands along the south river bank. The data obtained was submitted to a Board of Engineer Officers, and the recommendation of the Board to open navigation around the shoals by means of a lateral canal excavated through the bottom lands along the south bank was approved November 28, 1890. The existing project, therefore, contemplates the construction of a canal on the south bank of the river, 7.8 miles long, 150 feet wide at the water surface, and a

depth of 7 feet. A combined lock, with a total lift of 25 feet, is to be placed at the lower end and a guard lock at the head for use when necessary at very high water, the locks to be 80 by 350 feet and a depth of 6 feet of water on the miter sills at extreme low water.

A survey party was organized in April to locate the proposed canal, and to determine depth of rock suitable for lock foundations, character of soil to be excavated, amount of channel excavation at the approaches, extent of lands to be purchased, and such other data as is required to prepare the drawings and plans necessary to properly carry on the work of construction.

The party began operations in May and at the end of the fiscal year 4.5 miles of the proposed canal were located and staked out; preliminary lines were run to get an accurate topographical knowledge of the ground before determining the final line. Four permanent gauges were established, connected by a line of levels, and daily record kept of the gauge readings. Soundings were taken in the river below the lower entrance every 20 feet on lines 20 feet apart. Cross sections, extending up to high-water level, were taken every 100 feet, and at shorter intervals where the ground was irregular; borings were made at these cross sections to determine character of subsoil. Twelve pits were sunk to rock along the lower 2 miles of the route to accurately determine its character and extent. The topographical maps were plotted as field work progressed.

Of the \$150,000 allotted for the improvement of Colbert and Bee Tree Shoals in accordance with the approved project, \$4,670.20 were expended up to the close of the fiscal year.

BRIDGES.

The new draw in the bridge at Florence is completed, but three old piers still obstruct the channel. The owners have been duly notified to remove these obstructions and to modify the abutment pier; work in compliance with the notice is now under way.

The money statement for this work is consolidated with that for Tennessee River below Bee Tree Shoals (Appendix E E 1), so as to embrace the entire reach of the river below Chattanooga, as follows:

TENNESSEE RIVER BELOW CHATTANOOGA, TENNESSEE.

Money statement.

July 1, 1890, balance unexpended.....	\$35,501.30
Transfer settlements 5712, 5740, and 6023.....	3.91
Amount appropriated by act approved September 19, 1890.....	475,000.00
	<hr/>
	510,505.21
June 30, 1891, amount expended during fiscal year.....	160,619.65
	<hr/>
July 1, 1891, balance unexpended.....	349,885.56
July 1, 1891, outstanding liabilities.....	\$17,369.91
July 1, 1891, amount covered by uncompleted contracts ..	27,585.60
	<hr/>
	44,955.51
	<hr/>
July 1, 1891, balance available.....	304,930.05
	<hr/>
{ Amount (estimated) required for completion of existing project.....	5,565,762.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	2,155,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	•

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COMMERCIAL STATISTICS FROM JULY 1, 1890, TO JUNE 30, 1891.

Between Chattanooga, Tenn., and Decatur, Ala.

	Tons.		Tons.
Lumber.....	653	Flour.....	61
Cotton.....	590	Cotton seed.....	93
Live stock.....	2	General merchandise.....	451
Grain.....	1,166	Logs.....	37,500

Total number of tons, 40,506.

Between Florence, Ala., and Paducah, Ky.

	Tons.		Tons.
Iron.....	10,299	Grain.....	14,843
Staves.....	3,427	Flour.....	6,409
Lumber.....	29,172	Cotton seed.....	1,194
Cotton.....	5,029	Sand.....	2,100
Peanuts.....	4,294	General merchandise.....	28,998
Live stock.....	1,384	Logs.....	297,739
Hoop poles.....	473	Railroad ties.....	30,000

Total number of tons, 435,466; total number of passengers, 17,025.

New lines of transportation established.—Tennessee, Ohio and Mississippi River Transportation Company, between Chattanooga, Tenn., and St. Louis, Mo. Tennessee River Navigation Company, between Sheffield, Ala., and Paducah, Ky.

List of steamboats (stern wheel) plying on the Tennessee River below Chattanooga, Tenn.

Name of boat.	Length.	Breadth.	Depth.	Tonnage.
<i>Between Chattanooga, Tenn., and Decatur, Ala.</i>				
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Tons.</i>
Dixie.....	80.0	19.0	2.2	68.33
B. F. Young.....	120.0	24.3	4.0	160.96
R. T. Coles.....	118.0	24.6	4.2	134.91
R. C. Gunter.....	153.0	28.0	4.0	337.30
Herbert.....	134.0	27.8	2.6	167.00
<i>Below Florence, Ala.</i>				
Helene.....	194.0	33.0	4.5	262.31
City of Florence.....	160.0	32.0	5.3	358.81
City of Savannah.....	186.0	31.0	5.0	535.55
City of Sheffield.....	180.0	35.0	5.5	650.00
City of Paducah.....	183.0	37.0	5.25	700.00
W. F. Nisbet.....	200.0	35.0	6.1	576.86
Clyde.....	181.0	32.5	5.6	382.96
C. Smith.....	132.0	29.0	3.5	226.39
A. J. Duncan.....	165.0	.....	5.0	300.00
Ironside.....	154.0	30.0	5.4	262.30

Comparative statement of freight rates charged by steamer and by railroad between Florence and Sheffield, Ala., and points on the Ohio and Mississippi rivers.

[Pig-iron per ton of 2,268 pounds—tariff of 1890.]

From Florence and Sheffield to—	By water.	By rail.
Paducah, Ky.....	\$1.25	\$2.35
Cairo, Ill.....	1.25	2.50
Evansville, Ind.....	1.50	2.50
Louisville, Ky.....	2.00	2.25
Cincinnati, Ohio.....	2.25	2.50
Bridgeport, Ohio.....	2.75	4.15
Wheeling, W. Va.....	2.75	4.15
Pittsburg, Pa.....	3.00	4.15
St. Louis, Mo.....	2.00	2.80

To Florence and Sheffield from—	Bacon per 100 pounds.		Grain, hay, and bran per 100 pounds.		Flour per barrel.	
	By water.	By rail.	By water.	By rail.	By water.	By rail.
	<i>Cents.</i>	<i>Cents.</i>	<i>Cents.</i>	<i>Cents.</i>	<i>Cents.</i>	<i>Cents.</i>
Paducah, Ky., and Cairo, Ill.....	15	22	124	17	25	39
Evansville, Ind.....	20	25	15	20	25	44
St. Louis, Mo.....	20	25	15	23	40	50

REPORT OF BOARD OF ENGINEERS ON IMPROVEMENT OF THE "SUCK."

ENGINEER OFFICE, U. S. ARMY,
Nashville, Tenn., October 22, 1890.

GENERAL: The Board of Engineer Officers constituted by Special Orders No. 83, Headquarters, Corps of Engineers, December 16, 1889, reconvened at Nashville, Tenn., on the call of the senior member, October 18, 1890.

By an indorsement dated office Chief of Engineers, January 3, 1890, on a letter addressed to the Chief of Engineers by Lieut. Col. J. W. Barlow, under date of December 30, 1889, the consideration by this Board of a project for the removal of obstructions in the Tennessee River—commonly known as the "Suck"—was required.

On October 18, 1890, the Board proceeded to Chattanooga, Tenn., and on the following day made a personal examination of the obstructions. The information furnished by such examination, and by former examinations, surveys, and reports, enable the Board to submit the following report:

A detailed examination of the "Suck" was made by Lieut. Col. S. H. Long, topographical engineer, in 1830, and a full description of this section of the river, with project for improvement, is given in his report on Holston and Tennessee rivers, made to the Board of Internal Improvement for East Tennessee, and printed as Ex. Doc. No. 167, Forty-third Congress, second session. A full description of these obstructions is also given in a report on examinations and surveys on the Tennessee River by Assistant Engineer W. B. Gaw (under date of February 11, 1868) to General Weitzel, Corps of Engineers.

The obstructions known as the "Suck" commence about 13 miles below Chattanooga, Tenn., and extend downstream over a distance of about 9 miles. They form a series of rapids separated by pools, known as the Tumbling Shoals, the Suck, the Boiling Pot, the Pan, and the Skillet, and are formed by bars of gravel, bowlders, and detached and solid rock, and by the contraction of the section of the river and the excessive slope, resulting from the passage of the river through a gorge in the Cumberland Mountains. During low water these falls are obstructions, owing to lack of depth and excessive current; and during high water, while the depth is sufficient, the current is in some cases so increased by the narrow cross section as to render navigation almost impossible. In 1869-70 a little work was carried out for the improvement of the Pot and the Suck, consisting in the dredging of bowlders, loose rock, and gravel. Some good is reported to have resulted from this work.

A radical improvement of this section of the Tennessee River, which would render navigation free, easy, and unobstructed at all times, would necessarily consist of an enlargement of the river section and channel excavation for the distribution of slope over a sufficient length, or the construction of canals or slack-water navigation for use at all stages of the river up to its highest floods. The first method is impracticable, and the great expense of the second method renders it unworthy of consideration, at least at the present time.

All the projects heretofore presented for the improvement of low-water navigation of the Suck have contemplated the deepening and straightening of the channel through the rapids, by dredging of rock and gravel, the removing of certain detached rocks, bowlders, and projecting points, which now cause troublesome whirls and eddies, the construction of dams for changing slope and reducing currents, and arrangements for facilitating the hauling of boats up the rapids by means of lines and

capstans; a slight enlargement of the high-water section by the removal of trees and certain rocky projections has also been proposed.

It is the opinion of the Board that work of the above character, if carried out with judgment, will make the passage of the obstructions here considered easier, and that it is the proper class of improvement to be applied, when funds may be available, and after the necessary data has been obtained to permit of a careful and detailed study of the problem.

The surveys of the "Suck" heretofore made, and which are now before the Board, are not sufficiently detailed and complete to furnish the information as to channel depths, slopes, and other matters needed for projecting the entire work. A detailed examination should be made for determining the location and extent of obstructions, and the depths and slopes in the channel on the rapids and in the connecting pools, with a view to determining the probable effect on the depth and current of the pools of the work proposed for decreasing slope and increasing the depth on the rapids.

While much of the work contemplated for the improvement of the navigation of the "Suck" can not be safely undertaken in advance of the detailed examinations above referred to, it appears that there is some work, such as the removal of obstructive detached rock and bowlders, the clearing of banks for facilitating high-water flow, the smoothing of shores, and providing ring bolts to facilitate pulling boats upstream, and the deposit of such material below the rapids so as to prolong the fall and reduce the slope can be undertaken to advantage whenever funds are available for such work, and the employment of a small party for the carrying out of such partial improvements will offer most favorable opportunities for detailed observations and study of the obstructions.

Respectfully submitted.

J. W. BARLOW,
Lieut. Col., Corps of Engineers.
A. MACKENZIE,
Major, Corps of Engineers.
H. M. ADAMS,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 25, 1890.

Approved.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

REPORT OF BOARD OF ENGINEERS ON IMPROVEMENT OF LITTLE MUSCLE SHOALS, TENNESSEE RIVER.

ENGINEER OFFICE, U. S. ARMY,
Nashville, Tenn., October 23, 1890.

GENERAL: The Board of Engineer officers constituted by Special Orders No. 83, Headquarters, Corps of Engineers, December 16, 1889, "to examine and report what changes and additions are required in the

Muscle Shoals Canal system," was instructed, by a letter dated Office Chief of Engineers, December 17, 1889, "to examine and report fully upon the navigation and aids to the same upon the Little Muscle Shoals" of the Tennessee River.

In January, 1890, the Board made a trip over Little Muscle Shoals and had under consideration the maps and data at that time available. Under date of January 13, 1890, the following report upon the Little Muscle Shoals was submitted by the Board:

The Board, having carefully examined the maps and profiles of Little Muscle Shoals, and personally tested the current in the channel, are of the opinion that the present method of improvement by excavation and wing dams is insufficient to provide a slope that will admit of practical upstream navigation at all stages of the river. In the upper part of these shoals the fall at low water is 13 feet in a distance of 15,000, or an average of 4.6 per mile. From the foot of this steep decline to Florence the slope is 9 feet, or about 2 feet per mile.

The Board are of the opinion that the only practicable method of providing safe and easy upstream navigation during low water at the upper portion of the Little Muscle Shoals is by a canal and locks; but it is the further opinion of the Board that the surveys and data now available are not in sufficient detail to permit of the careful preparation of proper plans and estimates. The Board would therefore propose to defer their report upon the further improvement of navigation at the Little Muscle Shoals until a detailed survey of Little Muscle Shoals can be made and plans and estimates for a canal, based on such survey, be available for consideration.

The detailed survey proposed by the Board having been made, under Lieutenant-Colonel Barlow's direction, by Lieutenant Goethals, and plans and estimates for a canal having been prepared, the Board reconvened at Nashville, Tenn., on October 18, 1890, for the further consideration of the subject, and having carefully studied all the data available, including the result of the new survey by Lieutenant Goethals, it has the honor to submit the following report:

The Little Muscle Shoals of the Tennessee River commence at a point 1 mile below the lower end of the Big Muscle Shoals Canal and extend downstream a distance of $3\frac{1}{2}$ miles. The channel through the rock bed of these shoals at low-water stages is so crooked, of such insufficient depth, and the current is so rapid, that successful navigation is impracticable over this stretch of the river at low-water stages.

The only work carried out heretofore for the improvement of navigation over these shoals has consisted in rock excavation for widening and deepening the channel and the construction of dams for raising the water surface. A slight betterment of the channel has resulted from the work carried out, but it is the opinion of the Board that, owing to the character of the bed of the river and to the excessive slope and resulting rapid current, such a channel as will eventually be required for navigation of the Tennessee River can not be secured by a continuation of the open channel improvement.

The plan of improvement proposed for the Little Muscle Shoals by the board of internal improvement in 1831 was a canal along the north side of the river. A similar plan was recommended by Maj. Walter McFarland, Corps of Engineers, in 1872, and it is the opinion of the Board that the radical improvement of navigation at these shoals can best be accomplished by such canal construction.

The Board would recommend the construction of a canal commencing at a point on the north bank about 7,400 feet below Lock 9 of the Big Muscle Shoals Canal, following down the shore 15,000 feet and entering the river about 12,000 feet above the railroad bridge at Florence, Ala. The canal is to be formed by an embankment in the bed of the river, built of earth with core of clay, and protected on the outside by riprap and paving, and on the inside by riprap; the embankment to be 12 feet

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wide on top, with slope of 1 on 2 outside and 2 on 3 inside, and having a height of 6 feet above the high water of 1879. A lock at the foot of the canal of the same size as those of the Big Muscle Shoals Canal, that is, 60 feet by 300 feet, with a lift of 12 feet, will overcome the total fall. A guard lock at head of the canal for use in high water is provided. The canal will furnish a depth of 6 feet at low water, and be available for use up to the highest stage, extraordinary floods which in themselves prohibit navigation not being considered. The proposed plans of canal are based on a width of prism of not less than 150 feet at any point, and in some parts this width is exceeded. The canal is connected with the deep pool below Lock 9 of the Big Muscle Shoals by a channel excavated through the rock.

From the foot to the canal to Florence the fall of the river at low stages is 8 feet in a distance of 12,000 feet, giving a current varying from 2.77 miles per hour at low water, to 4.66 miles per hour at high water. The depth over the section is not at the present time sufficient at low water for such navigation as is being provided for by the canals around the Muscle Shoals, and it will eventually require deepening, either by dredging and the closing of secondary channels, or by the extension of the Little Muscle Shoals Canal to Florence. While an approximate estimate is presented for such extension of the canal, it is the opinion of the Board that such work need not be considered until experience proves it to be necessary.

The following estimate of the probable cost of this proposed canal around the Little Muscle Shoals is presented:

Rock excavation, 46,666 cubic yards, at \$6	\$279, 996
Rock excavation, 29,679 cubic yards, at \$4	118, 716
Earth in embankment, 304,889 cubic yards, at 40 cents	121, 955
Riprap and gravel on embankment, 228,333 cubic yards, at \$1	228, 333
Clay in embankment, 21,777 cubic yards, at \$1	21, 777
Paving embankment, 109,433 square yards, at \$1	109, 433
Lift lock	200, 000
Guard lock	150, 000

	1, 230, 210
25 per cent. for superintendence and contingencies	307, 552
	1, 537, 762

The estimated cost of the continuation of the canal to the Florence bridge is placed at \$1,500,000.

Respectfully submitted.

J. W. BARLOW,
Lieut. Col., Corps of Engineers.
A. MACKENZIE,
Major, Corps of Engineers.
H. M. ADAMS,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 28, 1890.

Respectfully submitted to the Secretary of War.

The Board of Engineer Officers, constituted by authority of the Secretary of War of December 13, 1889, submits the within report recom-

mending the construction of a canal to overcome obstructions to navigation at Little Muscle Shoals, Tennessee River.

The only work carried out heretofore for the improvement of navigation over these shoals has consisted in rock excavation for widening and deepening the channel and the construction of dams for raising the water surface; but it is the opinion of the Board that, owing to the character of the bed of the river and to the excessive slope and resulting rapid current, such a channel as will eventually be required for navigation of the Tennessee River can not be secured by a continuation of the open channel improvement.

The views of the Board are concurred in by me and the plan of improvement proposed is recommended for approval.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

WAR DEPARTMENT,
October 29, 1890.

Approved as recommended by the Chief of Engineers.

L. A. GRANT,
Acting Secretary of War.

REPORT OF BOARD OF ENGINEERS ON IMPROVEMENT OF COLBERT AND BEE TREE SHOALS, TENNESSEE RIVER.

ENGINEER OFFICE, U. S. ARMY,
Nashville, Tenn., October 28, 1890.

GENERAL: The Board of Engineer Officers constituted by Special Orders No. 83, Headquarters, Corps of Engineers, U. S. Army, Washington, D. C., December 16, 1889, "to examine and report what changes and additions are required in the Muscle Shoals canal system," was instructed by your letter of December 17, 1889, to examine and report fully upon the Colbert and Bee Tree shoals of the Tennessee River.

The Board during its session in January, 1890, made a personal and detailed examination of the Colbert and Bee Tree shoals, and had under consideration the various plans suggested previous to that date for their improvement, and such maps and records bearing upon the subject as were then on file in the United States engineer office at Nashville, Tenn. The data available at the time not being sufficient to determine the effect of these obstructions upon the existing interests of navigation, or the character and extent of improvement justified by the prospective commerce of the Tennessee River, the Board found it necessary to delay the preparation of a report upon the subject until further surveys could be made and additional facts and opinions could be secured. October 18, 1890, the Board reconvened at Nashville, Tenn., and remained in session 11 days. During this meeting careful consideration was given to the new data furnished by the additional detailed surveys made subsequent to first meeting of the Board. On October 27 a further personal examination was made of the Muscle Shoals canal system and the Colbert and Bee Tree shoals, the routes proposed for canals around the latter obstruction being carefully gone over. All the available information regarding the present conditions of navigation on Colbert and Bee Tree shoals and the relation of these obstructions to present and prospective commerce being now at hand, and full consideration having been given to the questions involved, the Board has the honor to submit the following report:

The Colbert and Bee Tree shoals, which are the most serious obstruction to navigation on the Tennessee River below the Muscle Shoals, extend from a point 22 miles below Florence, Ala., to Waterloo, Ala., a distance of about 8.7 miles. The total fall of water surface at low water in this distance is about 24.5 feet, the fall on Colbert Shoals being about 3.15 feet per mile, and on Bee Tree Shoals about 4.83 feet per mile. The shoals are separated by a pool about 1.95 miles in length, with a total fall of 0.8 feet. At ordinary low water the depth in the channel over the rocks at the head of Colbert Shoals is only 30 inches, and at extreme low water less than 1 foot; for from 5 to 7 months in the year the depth is less than 5 feet. At all times, except during high stages, the current on these shoals is so swift as to materially interfere with the interests of navigation, even when a sufficient depth of water is found in the channel. As bearing upon the present and prospective commerce of the Tennessee River and the relation to such commerce of the proposed improvement of Colbert and Bee Tree shoals, the following extracts from a letter received by the Board from the general manager of the Evansville, Paducah and Tennessee River Packet Company are given:

At the present time there are five regular packets navigating the Lower Tennessee as high as Florence, Ala. * * * The combined tonnage of these boats is about 3,000 tons, and they run to Waterloo, Ala. (which is at the foot of Colbert Shoals), all the year round, extending their trips to Florence from 5 to 7 months during the year. The heaviest of these boats, when loaded, draws 7 feet, and it is only now and then during the high-water season that they find sufficient water on the shoals to enable them to load to their full capacity. The business of these boats is entirely local and it is nearly all confined to points below the shoals, owing to the unreliability of navigation higher up, and it is a fact beyond dispute that the 35 miles from Florence to Waterloo is capable of giving more business to the river than the 265 miles from Waterloo to Paducah. In making this statement through business to points beyond Sheffield and Florence has not been considered. * * * It would be difficult to estimate the importance of river improvement that would insure river navigation to Sheffield and Florence all the year round. The local business of the river would be largely increased, and the amount of through business to and from the Ohio and Mississippi rivers that would naturally go over this route can hardly be estimated. * * * Our information is that the Muscle Shoals Canal will not admit a boat drawing more than 5 feet. According to the opinion of many steamboatmen and others who have knowledge on this subject, 5 feet is inadequate for the class of boats that run to Florence. Towboats often load their barges to 8 or 9 feet, and, as before stated, our boats draw 7 feet loaded. Whenever the improvement is made it should be made to correspond with the river below Colbert Shoals instead of above, as anything short of this will not likely meet the demand. * * * Thousands of tons are taken out of the Lower Tennessee every year by towboats, and the business of towboats would be increased more than any other if navigation could be regular. The Tennessee is susceptible of lasting and permanent improvement, and with the expenditure of a comparatively small sum 5 to 6 feet of water could be had from Waterloo to Paducah during the lowest stage of the river, which usually lasts but a short time.

The work heretofore carried out for the improvement of navigation on the Colbert and Bee Tree shoals has consisted of rock excavation and the construction of stone dams for concentrating the water in the channel. This work has possibly resulted in a very slight deepening of the channel at low water, but owing to the excessive slope and resulting current at low and even ordinary stages, which current has been increased by the work carried out, it is apparent that an improvement by this method which would furnish an easily navigated channel at all stages, especially for tows, is impracticable at any reasonable expense. To give a proper depth and a practicable slope and current would necessitate the drawing down of the pools above, which latter result would probably develop new and serious obstructions. All that it appears

practicable to gain by continuing this method of improvement will be a slight betterment of the channel for descending navigation.

Under date of January 9, 1888, Lieutenant-Colonel Barlow, Corps of Engineers, the officer in charge of the improvement of the Tennessee River, presented a preliminary report upon the improvement of Colbert and Bee Tree shoals, in which he advocated the abandonment of further channel excavation and wing-dam construction, and the substitution of a plan of locks and dams. It was then suggested that slack-water navigation be provided by the construction of dams with locks at the foot of the shoals.

Subsequently to the presentation of this preliminary report, and after a more detailed personal examination of the locality had been made, the officer in charge decided to modify his original plan by the substitution of lateral canals for the cross dams. The lateral canal at Colbert Shoals, about $3\frac{1}{2}$ miles long, was to be formed by Brush Creek Island and an embankment about 14,000 feet in length. At Bee Tree Shoals the canal, about 2 miles long, was to be formed by Bee Tree and Waterloo islands and a connecting embankment about 1,200 feet in length. This system of improvement was presented to the Chief of Engineers in a report dated December 21, 1889, which report is referred to this Board for its information.

The Board are of the opinion that the only radical and proper method of overcoming the obstructions to navigation now found at Colbert and Bee Tree shoals of the Tennessee River, so as to protect the present commerce and provide for the necessities of the prospective commerce, is by a system of locks and dams; and the construction of the lateral canals in the bed of the river, behind existing islands, or on some other feasible route, is considered preferable to the construction of cross dams with locks, for the reason that by such plan the main river will be left free and unobstructed for the use of boats and other floating craft during the portion of the year—about 6 months—when the shoals can be navigated in their natural state.

The lateral canal improvement under consideration should provide not only for the present commerce of the Tennessee River, but also for the prospective commerce, which will be made possible by, and surely follow, the improvement of the Colbert and Bee Tree Shoals and other obstructed points between the foot of these shoals and the mouth of the river.

It is the object of these canals to make navigation of the Tennessee between Waterloo and Florence safe, easy, and continuous throughout the year for such boats as are best suited for the business of the river. While the size and draft of all boats engaged in through navigation will necessarily be limited, for the present at least, by the existing Muscle Shoals Canal, and by the gravel bars and shoals between this point and the Ohio River, it is not thought that the capacity of the Muscle Shoals Canal should entirely govern in deciding upon the capacity of canals or other work of improvement below Florence, there being a large prospective river commerce which will originate in this section of the river and which will not be immediately interested in the river above.

Detailed surveys are needed for determining definitely the full extent to which the Tennessee River below Florence is capable of being improved, but enough information is now available to indicate that a low-water ruling depth of 6 feet can eventually be secured, and such low-water draft should be provided for in the canals around the Colbert and

Bee Tree Shoals by placing the mitre sills of the locks at a depth of not less than 6 feet below the adopted low-water plane and excavating the canals to a depth of not less than 7 feet below low water, and as much deeper as experience may show to be necessary to provide for deposits.

The canals should be available for use until the depth of water and strength of current in the open river are such as to make navigation in the main river safe, easy, and convenient for ascending as well as descending heavily laden boats and barges. The locks and embankments should be given heights of at least 4 feet and 1 foot respectively above the water surface of the canal at the highest stages at which the canal is to be used. There should be no current or side drafts in the canal so long as it is in use.

The locks of Muscle Shoals Canal, which are 60 feet wide and 300 feet long, now limit the dimensions of boats which may engage in through navigation of the Tennessee River, and such locks are of sufficient capacity for the class of boats now in use on the river below Florence. But with the improvement of the river from Florence to the mouth may come the necessity for larger boats, and, even if this be not considered probable, the business to be carried on by fleets of barges to and from points above the Muscle Shoals, and also to and from Florence and Sheffield, with the delay attending the passage of large tows through small locks, must be considered. It is the opinion of the Board that the locks of the proposed canals around the Colbert and Bee Tree Shoals should be at least equal in dimensions to the locks of the canals now operated by the Government on the Ohio and Mississippi rivers; that is, 80 feet wide and 350 feet long. Even a greater length may be desirable.

Plans for canals on the two routes which appear to be most practicable have been considered by the Board.

One plan contemplates two canals in the bed of the river, one around Colbert Shoals, and one around the Bee Tree Shoals. The canals are connected by 1.95 miles of navigable river. The inner bank of these canals is formed by the main left shore of the river, and the outer or river embankment is formed by existing islands, connected by masonry and riprap walls. At the foot of each canal is a single lift lock 80 by 350 feet, having at "ordinary low water" a depth of 6 feet over mitre sills, and lifts of 14.4 and 9.3 feet respectively at Colbert and Bee Tree Shoals. The canal walls and side embankments are placed at such a height as to furnish still water in the canals until the gauge at the head of Colbert Shoals reads 7 feet above "ordinary low water," at which stage it is stated the depth on the shoals is sufficient for such open-river navigation as is practicable on other portions of the river. Excavations are made in rock and gravel at the head and foot of the canals and approaches, furnishing a depth in a channel 200 feet wide or 7 feet at "ordinary low water." The width of the Colbert Shoals Canal varies from 200 to 1,360 feet, and of the Bee Tree Canal from 200 to 350 feet. The bottom of these canals having the slope of the bed of the river, a much greater depth than 7 feet is given near the lower ends. At all stages over 7 feet above ordinary low water at head of Colbert Shoals, the canals will be flooded. The other plans considered are for a canal 7.8 long and 150 feet wide, excavated through low ground at the foot of the bluffs south of the river and from 100 to 600 feet back from the left bank. Rock cutting is required at the head and foot of the canal. The canal bottom is level throughout and 7 feet below ordinary low water. The banks, for greater portion of the length, are formed by the

natural soil and the excavated material, and are from 40 to 260 feet thick at top. For a distance of about 1 mile the canal passes around the foot of a projecting bluff and occupies a portion of the river bed, requiring an embankment on river bed about 30 feet high. The top of the earthen portion of the embankment is placed 1 foot above the highest authenticated flood and the embankment in the river is above all recent floods. At the lower end of this canal is placed a combined lock with a total lift of 25 feet, and at the head is placed a guard lock for use, when found necessary, at very high water. The banks of this canal are protected by riprap. The canal is made available for use up to the highest stages, and will never be flooded.

The estimated cost of the lateral canals in the bed of the river behind existing islands is \$2,750,000. In preparing this estimate it has been necessary to take in consideration the difficulties attending the carrying out of excavation and construction in the bed of the rapid river, subject to sudden and frequent rises. Could a constant low-water season be depended on, the estimate could be materially reduced.

The cost of the canal on the south bank of the river is estimated at \$2,500,000.

The canals in the bed of the river, as compared with the shore canals, furnish, so long as in use, a wider and, for a long portion of length, a deeper channel, and they permit the taking advantage of the stretch of easily navigated river between Colbert and Bee Tree Shoals. In other respects the canal on the shore seems to possess decided advantages over the river works. Its construction will be carried on to a great extent on dry land, rather than in the bed of the river, with a rapid current and subject to sudden rises; the embankments, being of great thickness, with top above flood, and well back from the river, will be more secure and permanent than the walls and embankments of the at times submerged river canal; the location of the shore canal near the bluff and behind the high timber along the river bank provides for shelter from heavy winds, which winds would at times interfere materially with the navigation of the excavated channel of 200 feet in the rocky bed of the river canal; and the height projected for locks and embankments provides for the possible use of the shore canal at any and all stages from the lowest to the highest, while in case of river canal the use of open river over a stage of 7 feet above ordinary low water is a necessity. Sediment will be brought into a shore canal from the river through the locks and by the creeks along its route, and this will probably be its most serious defect; but, being easily remedied by dredging, is not considered so great as to outweigh the advantages above considered.

The Board would, for the reasons herein given, recommend as the most proper plan for removing the obstructions to navigation at the Colbert and Bee Tree shoals of the Tennessee River the construction of a canal on the south bank of the river as herein described.

The Board has not given detailed consideration to any plan for cross dams and locks and a slack-water improvement, it being in their opinion inexpedient to interfere with the free and unobstructed navigation of the open river, which is practicable during a large portion of the year. If a slack-water improvement of the main channel of the river were decided practicable and advisable its cost would undoubtedly be much less than the cost of the proposed canal.

An outline map of the section of the river including Colbert and Bee Tree shoals, upon a scale of 1 inch to 800 feet, and upon which are shown

the location of the two lines of canals under consideration, is transmitted herewith.

Respectfully submitted.

J. W. BARLOW,
Lieut. Col., Corps of Engineers.
A. MACKENZIE,
Major, Corps of Engineers.
H. M. ADAMS,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
November 13, 1890.

Respectfully submitted to the Secretary of War.

The Board of Engineer Officers constituted by authority of the Secretary of War of December 13, 1889, submits the within report recommending the construction of a canal on the south bank of the river to overcome the obstructions to navigation at the Colbert and Bee Tree shoals of the Tennessee River.

The work heretofore carried out for the improvement of navigation on the Colbert and Bee Tree shoals has consisted of rock excavation and the construction of stone dams for concentrating the water in the channel; but owing to the excessive slope and resulting rapid current it is apparent that an improvement by this method, which would furnish an easily navigated channel at all stages, is impracticable at any reasonable expense.

The views of the Board are concurred in by me and the plan of improvement proposed is recommended for approval.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT,
November 28, 1890.

The plan of improvement recommended by the Chief of Engineers is approved.

L. A. GRANT,
Assistant Secretary of War.

F F 2.

OPERATING AND CARE OF MUSCLE SHOALS CANAL, TENNESSEE RIVER.

The Muscle Shoals Canal, which has been in the course of construction since 1875, was formally opened to public traffic on the 10th day of November, 1890.

The canal consists of two sections, the Elk River Division and the Muscle Shoals Division; the former is 1.5 miles long and has two locks,

each 60 by 300 feet, with a total lift of 23 feet. The Muscle Shoals Division, beginning about 8 miles below, is 14.5 miles long and has been constructed by rebuilding and enlarging the old canal built by the State of Alabama, 1831-1836. This canal was used one season, but the obstructions in the river above and below permitted navigation only during certain stages of the water; as no funds were appropriated for its maintenance it was abandoned in 1837.

As reconstructed, this division contains 9 locks of same dimensions as those in the upper division with a total lift of 85 feet.

Since the opening of the canal, the locks, machinery, and surroundings have been cared for and kept in good condition. The canal embankment was inspected daily, along its entire length, for the purpose of detecting and locating leaks; all serious ones were promptly repaired.

Several small breaks were made in the longitudinal dam above Lock A by drift during the last high water; these have been partially repaired; 168 cubic yards of riprap stone taken from the Bluff quarry were used for this purpose.

One serious break occurred on the Muscle Shoals Division; on February 11 about 40 linear feet of the outer embankment at the lower end of the aqueduct washed out to river level; 250 cubic yards of earth and 25 cubic yards of stone were used in repairing this break, and the canal was put in working order by February 14; no delay to traffic resulted from the accident.

The United States dredge *Harwood* removed 2,200 cubic yards of sediment that had been deposited in the entrance to the canal by the river and First Creek during high water; also 2,426 cubic yards from between Locks 2 and 4, deposited by Bluewater Creek and small branches.

The tug *McFarland* was employed assisting tows through the canal, and when necessary two locomotives were used for similar purposes.

Money statement.

Amount estimated to June 30, 1891, allotted	\$40,000.00
June 30, 1891, amount expended during fiscal year.....	14,313.45
July 1, 1891, balance unexpended	25,686.55
July 1, outstanding liabilities	2,478.59
July 1, 1891, balance to be covered into Treasury.....	23,207.96
Amount (estimated) required for operation and care to June 30, 1892.....	55,000.00

2324 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Detailed expenses incurred for operating and care of Muscle Shoals Canal from November 10, 1890, to June 30, 1891.

Month.	Office and administration.			Operating, care, repairs, etc.									Grand total.
				Locks A and B.				Locks 1 to 9.					
	Salaries.	Supplies.	Total.	Labor.	Subsistence.	Supplies.	Total.	Labor.	Subsistence.	Supplies.	Total.		
1890.													
Nov.		\$157.42	\$157.42	\$240.00			\$240.00	\$630.00			\$630.00	\$1,027.42	
Dec.	\$120	1.75	121.75	405.00	\$67.17		472.17	542.50	\$161.81		664.31	1,258.23	
1891.													
Jan.	270		270.00	205.00			205.00	1,233.49			1,233.49	1,808.49	
Feb.	270		270.00	395.00	70.06		465.06	1,642.50	163.21		1,805.71	2,540.77	
Mar.	195		195.00	425.00			425.00	1,450.67	241.42		1,691.09	2,321.09	
Apr.	225		225.00	470.00	66.07	\$3.10	539.17	1,650.66		\$14.10	1,664.76	2,428.93	
May.	225	15.00	240.00	445.00	85.15	27.00	557.15	1,650.50	107.21	191.77	1,958.48	2,755.63	
June.	250		250.00	430.76	70.45		501.21	1,562.49	175.50	72.28	1,810.27	2,561.48	
	1,555	174.17	1,729.17	2,057.33	205.76	358.90	3,013.50	3,404.76	1,340.81	849.15	2,788.11	4,668.11	
												16,792.04	

Traffic through the Muscle Shoals Canal during fiscal year ending June 30, 1891; canal opened to navigation November 10, 1890.

Steamers.....	number..	26	Flour.....	tons..	640
Barges.....	do.....	19	Oak extract.....	tons..	578
Rafts.....	do.....	7	General merchandise.....	tons..	130
Tonnage.....	tons..	4,257	Logs.....	do.....	280
Lumber.....	do.....	645	Total.....	do.....	3,296
Cotton.....	do.....	157	Passengers.....	number..	175
Grain.....	do.....	866			

The above statement of traffic does not include Government boats engaged on the work.

ESTIMATE.

The estimate of funds needed from appropriation for operating and care of canals and other works of navigation, indefinite. To be applied to current expenses in operating the Muscle Shoals Canal from July 1, 1891, to June 30, 1892, is as follows.

1 assistant engineer, at \$175 per month.....	\$2,100
1 master mechanic, at \$100 per month.....	1,200
11 lockmasters, at \$75 per month each.....	9,900
11 assistant lockmasters, at \$40 per month each.....	5,280
1 clerk, at \$100 per month.....	1,200
1 engineer at machine shop, at \$60 per month.....	720
1 telephone lineman, at \$50 per month.....	600
2 blacksmiths, at \$75 per month each.....	1,800
1 carpenter, at \$80 per month.....	960
2 overseers, at \$80 per month each.....	1,920
25 laborers, at \$30 per month each.....	9,000
Dredging and towboat crews, \$700 per month.....	8,400
Subsistence, \$450 per month.....	5,400
	48,480
Material and contingencies.....	6,520
Total for year.....	55,000

F F 3.

PRELIMINARY EXAMINATION OF MOUTH OF GUNTER'S CREEK AT GUNTERSVILLE, ALABAMA, WITH THE VIEW OF ASCERTAINING THE PRACTICABILITY AND APPROXIMATE COST OF SO IMPROVING THE SAME AS TO SECURE A SAFE LANDING ABOVE HIGH-WATER MARK.

[Printed in House Ex. Doc. No. 132, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 27, 1890.

SIR: I have the honor to submit the accompanying copy of report, dated December 23, 1890, by Lieut. Col. J. W. Barlow, Corps of Engineers, giving results of a preliminary examination of "mouth of Gunter's Creek, at Guntersville, Ala., with the view of ascertaining the practicability and approximate cost of so improving the same as to secure a safe landing above high-water mark," made in compliance with requirements of the river and harbor act approved September 19, 1890.

Colonel Barlow states that the present landing is sufficient for all present needs of commerce, and that he does not consider the mouth of Gunter's Creek worthy of improvement as contemplated by the act..

The views of Colonel Barlow meet with my approval.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF LIEUTENANT-COLONEL J. W. BARLOW, CORPS OF ENGINEERS.

ENGINEER OFFICE, U. S. ARMY,
Nashville, Tenn., December 23, 1890.

GENERAL: In compliance with instructions contained in Department letter of September 20, 1890, I have the honor to present the following report upon a preliminary examination of "mouth of Gunter's Creek, at Guntersville, Ala., with the view of ascertaining the practicability and approximate cost of so improving the same as to secure a safe landing above high-water mark."

Having visited the locality on several previous occasions, a personal examination at this time was not considered necessary. Assistant Engineer J. W. Walker, whose report is transmitted herewith, was however sent to Guntersville for the purpose of ascertaining the object of the improvement and such other information as might be obtainable.

The present landing, with the wharf-boat provided by the Tennessee River Transportation Company, affords more than the usual facilities at landings on the Tennessee River, and is considered sufficient for all present needs of commerce.

To provide the desired improvement would require the excavation of a navigable channel 1,800 feet long up Gunter's Creek, the bed of which is several feet above low water. The expense of making this channel would be considerable, involving the removal of about 75,000 cubic yards of material, and should, in my judgment, be borne by those interested in the local advantages to be gained thereby.

I therefore do not consider that the mouth of Gunter's Creek is worthy of improvement by the United States, as contemplated by the river and harbor act of September 19, 1890.

Very respectfully, your obedient servant,

J. W. BARLOW,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers U. S. A.

REPORT OF MR. J. W. WALKER, ASSISTANT ENGINEER.

NASHVILLE, TENN., December 22, 1890.

COLONEL: I have the honor to submit the following report on the preliminary examination of the "mouth of Gunter's Creek, at Guntersville, Ala., with the view of ascertaining the practicability and approximate cost of so improving the same as to secure a safe landing above high-water mark."

Guntersville is a village of about 450 inhabitants, county seat of Marshall County, located about three-fourths of a mile back from the river. The accompanying map has been prepared, and is made a part of this report.* It will be seen that Gunter Creek is a small tributary emptying into an unnavigable chute on the south bank of the Tennessee River, about 2,000 feet above the foot of Henry Island.

The high-water contour, as measured along the back chute and Gunter Creek, is upward of 3,500 feet from the present landing, and the width of Gunter Creek, from crest to crest of bank, is about 160 feet, while the bed of the creek will average an elevation of 6 feet above ordinary low water. The river bank at this locality is about 28 feet above ordinary low water, and I am told is overflowed two or three times a year, a submergence of from 15 to 18 days yearly.

The Tennessee River Transportation Company, owners of navigation plying between Chattanooga, Tenn., and Decatur, Ala., maintain and operate a wharf boat at Guntersville for the convenience of commerce, thus securing perfect protection from the weather as well as high water.

The object desired involves an excavation for a steamboat channel of so much of Gunter Creek as lies from its mouth up to where it cuts through the hill back of the bottom land, a distance of about 1,800 feet, and the removal of a bar of gravel deposited at its mouth in the chute. The object desired can only be effected at a great cost, and the prospective commerce of the place will not justify the improvement of the creek by the General Government.

I was not able to collect accurate statistics of the commerce of Guntersville, as there is no public necessity that causes the compilation of accurate records. Mr. A. J. Rains, local steamboat agent, gives the following statement as the estimated commerce of Guntersville by river, during the past year.

Articles.	Quantities.	Values.	Articles.	Quantities.	Values.
Shingles.....number..	75,000	\$187.00	Corn.....pounds..	300,000	\$3,000.00
Lumber.....feet, B. M..	500,000	5,000.00	Stock.....head..	200	3,000.00
Cotton.....pounds..	2,850,000	270,000.00	Hay.....pounds..	72,000	360.00
Floor.....do.....	540,000	10,200.00	Fertilizer.....do....	4,240,000	33,320.00
Salt.....do.....	10,800	540.00	Merchandise.....do....	768,000	.....

Very respectfully, your obedient servant,

J. W. WALKER,
Assistant Engineer.

Lieut. Col. J. W. BARLOW,
Corps of Engineers, U. S. A.

* Not printed.

APPENDIX G G.

IMPROVEMENT OF OHIO, MONONGAHELA, CHEAT, ALLEGHENY, AND MUSKINGUM RIVERS; CONSTRUCTION OF ICE-HARBOR AT MOUTH OF MUSKINGUM RIVER, OHIO.

REPORT OF LIEUTENANT-COLONEL WM. E. MERRILL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|--|--|
| 1. Ohio River. | 7. Purchase of Lock and Dam No. 7, Monongahela River. |
| 2. Operating snag boats on Ohio River. | 8. Purchase of Lock and Dam No. 6, Monongahela River. |
| 3. Operating and care of Davis Island Dam, Ohio River. | 9. Cheat River, West Virginia. |
| 4. Movable dam in Ohio River, near mouth of Beaver River, Pennsylvania. | 10. Allegheny River, Pennsylvania. |
| 5. Monongahela River, West Virginia and Pennsylvania. | 11. Dam at Herr Island, Allegheny River. |
| 6. Operating and care of Locks and Dams Nos. 8 and 9, Monongahela River. | 12. Ice-harbor at mouth of Muskingum River, Ohio. |
| | 13. Muskingum River, Ohio. |
| | 14. Operating and care of locks and dams on Muskingum River, Ohio. |

EXAMINATIONS.

- | | |
|---|--|
| 15. Harbor of Owensboro, Kentucky, on the Ohio River. | 17. Improving the Ohio River, between the mouth of Green River, in the State of Kentucky, and the city of Evansville, in the State of Indiana, and confining the waters of the first named river within its present channel, and preventing danger to navigation from any changes therein. |
| 16. Tionesta [Creek], Pennsylvania, from the town of Tionesta to the village of Balltown. | |

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, July 1, 1891.

GENERAL: I have the honor to submit herewith the annual reports on the works under my charge for the fiscal year ending June 30, 1891. First Lieut. C. E. Gillette, Corps of Engineers, has been on duty in this district during the past fiscal year.

Respectfully, your obedient servant,

WM. E. MERRILL,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

G G I.

IMPROVEMENT OF OHIO RIVER.

The river and harbor act of September 19, 1890, contained the following item:

Improving Ohio River: Continuing improvement, \$300,000, of which sum \$7,500 shall be expended in constructing an ice pier pursuant to the present or prospective plan of the Chief of Engineers at or near the mouth of Kerr Run, in Ohio: *Provided*, That the Secretary of War is hereby authorized and directed to obtain, if he can do so without cost to the United States, a perpetual lease or conveyance of the riparian rights of the property owners at said locality, in the event said ice pier shall be located where there is no landing place: *And provided further*, That at said locality, if it be an improved landing, he shall first obtain a relinquishment of wharfage right and dues in favor of water craft seeking protection from damage by ice; and no part of this appropriation shall be used for such purpose until the foregoing conditions are complied with; and a like sum for like purposes upon similar terms in all respects may be used in the discretion of the engineer in charge of the Ohio River at Ripley, Ohio, and at Portsmouth, Ohio; and \$20,000 of said Ohio River appropriation may be used for continuation of harbor improvement at Madison, Ind., according to the plans heretofore submitted by Lieutenant-Colonel Merrill; \$13,250 may be expended in the completion of the construction of the embankment on the south side of the Great Miami River near its junction with the Ohio to confine the waters of said Miami River in great floods to the general course of its channel at or near the Ohio, to the end that the formation of the bar in the Ohio now obstructing navigation may be arrested; and \$15,000 may be expended in completing the embankment at Shawneetown, already partly constructed, for the preservation of the harbor at that place; the further sum of \$20,000 may be expended for the removal of rock obstruction at the mouth of the Licking River, Kentucky.

The special allotments named above make a total sum of \$90,750, leaving \$209,250 for general improvement. As the Ohio River is 967 miles long, there is thus left \$216 per mile for the general benefit of navigation. It is evident that no great amount of work could be accomplished with so little.

It was decided to use the available funds in raising the dike at the foot of Marietta Island, in rebuilding the old dam at the head of Blennerhassett Island, and in building dikes at Cullum, at the bar below Rising Sun, and at Flint Island. Contracts for these works, and for works that received special allotments (except the Licking Bar, which is to be removed by hired labor), were made during the fiscal year.

Throughout the year the Ohio River was unusually high, and all classes of river work were greatly hindered by the unusual volume of water.

Dam between Davis and Neville islands, 5 miles below Pittsburg.—The object of this dam is to close the opening between Davis and Neville islands and to force all the water that passes the Davis Island Dam during low stages to go down the right-hand channel and thus increase the depth on Horsetail, Duff, Lowery, Merriman, and Whites. The wash around the Neville Island end of this dam was successfully stopped by crib work, and the Davis Island end was strengthened. Much difficulty has been experienced in holding the paving and filling of the lower slope of this dam, on account of the heavy fall at the dam, due to the great length of Neville Island, but it is believed that this difficulty can be overcome.

Dike at The Trap, 11 miles below Pittsburg.—After the subsidence of the spring floods it was noticed that the stone filling had washed out of two of the compartments on the lower slope of the dike and that some small damage had been done at two other places. Repairs were made as soon as practicable, and in addition ten of the top timbers that showed signs of decay were renewed.

Dam at Marietta Island, 168 miles below Pittsburg.—Under contract dated February 9, 1889, with Josiah T. Hart. The object of this dam is to close the left-hand channel of the Ohio River at this place, forcing all the water down the right-hand channel and past the city of Marietta, until the river reaches a stage of 7 feet and over on the Marietta gauge, when the discharge is divided between the two channels. The break in the dam, reported in the last annual report, was successfully filled, and the dam was completed and the contract closed in December, 1890. The dam is 916 feet long between abutments and contains 268,592 feet B. M. of timber, 14,087 cubic yards of stone filling, and 21,215 pounds of drift bolts and spikes. Water commences to run over this dam when the gauge at Marietta reads 7.6 feet. During the past winter some damage was done to the paving and filling of the down stream slope, but the main structure was not affected. At the close of the fiscal year the repairs were not quite completed, owing to rises in the river.

Dike at foot of Marietta Island, 171 miles below Pittsburg.—Under contract dated February 14, 1891, with J. C. Graham. The object of this dike is to hold up the water coming down the right-hand chute of Marietta Island, and prevent it from spreading until after it has passed the Marietta Wharf. It was originally built in 1844, and was repaired and extended in 1875. It is in good condition, but owing to the increased height given to the dam at the head of the island, it is necessary to raise the dike to the same height in order to cut off the cross current, which has already caused the loss of several coal barges. It is also proposed to rectify the alignment. At the close of the fiscal year work had not been begun under this contract.

Dam at head of Blennerhassett Island, 185 miles below Pittsburg.—Under contract dated February 14, 1891, with Richardson and Monroe. The object of rebuilding this dam (originally constructed in 1884), which had been gradually worn down, was to send more water down the navigable channel on the Ohio side of the island and to improve the bar at the foot. Including abutments, the total length of the proposed dam is 1,800 feet.

Work was begun on the 1st of May, and at the close of the fiscal year the abutment on the island side was completed for a length of 600 feet out of a total length of 700 feet, and the riprap protection of the banks was about finished. No work had been done on the dam proper on account of high water.

Dike at Eight-Mile Island, 256 miles below Pittsburg.—Under contract dated February 9, 1889, with John J. Shipman. The object of this dike is to deepen the water on the bar at the foot of Eight-Mile Island. This work, which was nearly complete at the close of the last fiscal year, is still not quite finished, long-continued high water having made it impracticable to do the small amount of riprapping and paving that still remains. On the recommendation of this office the contract was extended to December 31, 1891.

Dike at Bonanza Bar, 352 miles below Pittsburg.—Under contract dated February 9, 1889, with John J. Shipman. The object of this dike was to narrow the low-water channel and improve the very bad bar that had long been the shoalest place between Cincinnati and Catlettsburg. This dike has been fully completed, and its effect in improving navigation at the locality in question has been very decided. The total length of the dike is 2,212 feet, and the following quantities of material were expended in its construction: 598,515 feet B. M. timber, 21,630 cubic yards riprap stone, and 49,831 pounds drift bolts and spikes.

Dike at Cullum, 471 miles below Pittsburg.—Under contract dated

February 9, 1891, with John J. Shipman. The object of this dike is to strengthen and widen the channel by cutting off the narrow and crooked passage down the right-hand shore, and thus compel the river to make a new and more commodious channel across the present bar.

Work on this dike was begun on the 7th of May, and at the end of the fiscal year the dike extended into the stream 670 feet, measuring from the 15-foot water mark, though the 120 feet on the shore was left unfinished, to be completed with the shore protection.

Dike at lower bar at Rising Sun, 502 miles below Pittsburg.—Under contract dated February 9, 1891, with John J. Shipman. The object of this dike is to improve the lower bar at Rising Sun, which, since the improvement of the upper bar, has been the chief sticking place between Cincinnati and Louisville.

Work on this dike was begun on the 26th of May, and at the close of the fiscal year the upper row of piles had a length of 455 feet and the lower row of 400 feet. On account of high water no brush or stone had been put in place.

Dike at Madison, Indiana, 552 miles below Pittsburg.—Under contracts dated February 9, 1889, and February 14, 1891, with William Kirk. The construction of this dike was ordered by Congress, and its object is to improve the harbor of Madison by deepening the water on the flat shore bar that lies along the whole front of this city. At the close of the fiscal year the substructure extended into the river 2,250 feet, being the full proposed length of the dike. All of the brush filling had been put in place, and about five-sixths of the necessary stone. No work has yet been done on the superstructure.

Dike at Flint Island, 683 miles below Pittsburg.—Under contract dated February 14, 1891, with William Kirk. The object of this dike is to contract the river and thus deepen the water below Flint Island, there being two channels at this place, neither of which is deep enough for navigation during the low-water season. Work under this contract was begun on May 2, and at the close of the fiscal year the dike was about completed for a length of 950 feet, though the piling extends 200 feet further. The shore protection is finished.

Dike at Caseyville, 860 miles below Pittsburg.—Under contract dated February 9, 1889, with William Kirk. The object of this dike is to concentrate the low-water flow of the river so as to deepen the water on Caseyville Bar. The contract was only let for the substructure, and this was completed on the 15th of November. The new dike begins at Battery Rock, on the Illinois shore, and extends across the Illinois channel to the middle bar and along the eastern edge thereof. Its total length is 3,400 feet; its top is even with the 4-foot stage in the river, except a length of 400 feet where the dike crosses the bar, which is even with the 6-foot stage; 1,882 piles, 5,595 cords of brush and 27,810 cubic yards of stone were used in its construction.

The full effect of this dike on the depth of water on Caseyville Bar will not become apparent until the low-water season sets in, but I am informed by one of the most experienced pilots on that section of river that the dike has already been of great benefit in straightening the channel, not only at Caseyville, but at Tradewater and Weston, thereby facilitating navigation, especially with heavy tows. It is probable that the effect of the dike will increase in time, and that it will be more marked after the height has been raised by the crib-work top which is to be added at a later date.

Dike at Middle of Grand Chain, 946 miles below Pittsburg.—Under contract dated December 1, 1884, with I. V. Hoag, jr. The channel at the

Grand Chain is bordered on the right by reefs of rock along a length of about 6 miles, extending in some places to the middle of the river. The object of building dikes at this locality is to force the channel away from these rocks. One dike has been built at the head of the Chain and another at the foot, the dike in question being intermediate. It is the most unfavorable location for work on the Ohio River, as it is only 20 miles from the Mississippi, and flood stages in the latter river stop work at the Grand Chain almost as effectually as floods in the Ohio. This accounts for the slow progress of the work, and the long time that has elapsed since the contract was let. The last season was the most unfavorable that has yet been encountered; at no time during the year was the river low enough to permit the extension of the dike by sinking cribs, and the entire year's work was represented by the building of 100 feet of superstructure. The foundation line of independent cribs is 2,161 feet long; and a length of 2,019 feet is wholly completed, except paving, for about half its length. The intended length of the dike is 3,008 feet; it is therefore two-thirds done. On the recommendation of this office the contract was extended to December 31, 1891.

ROCK EXCAVATION.

Rock Bar at mouth of Licking River, 466 miles below Pittsburg.—Under contract, dated July 12, 1889, with John F. King. The contractor began work early in August, and the cofferdam was well under way when the river rose and partly wrecked it. As this was his second attempt, and as there was no prospect of an early resumption of work, the contractor finally decided to abandon his contract, and sent written notice to that effect on the 10th of August. As no rock had been excavated, no payments were made by the United States. Authority was requested and granted to make the excavation by hired labor. With this view cofferdam timber was bought and framed, and the necessary boilers, engines, and pumps were purchased. Everything was ready to prosecute the work with the utmost energy, but, after waiting in vain until November for a chance to begin the work, orders were finally given to abandon the effort and store the plant.

In June the material and plant were again brought to the ground, but at the end of the fiscal year the cofferdam had not yet been begun on account of the high stage of the river.

ICE PIERS.

Ice piers are high isolated cribs filled with stone, placed at the upper end of a landing in order to ward off ice and drift. An ice pier is usually built in two or more sections, with an interval between them somewhat greater than the width of a section, the lines of sections being at right angles to the shore or inclining downstream. As built on the Ohio River ice piers have a base of 24 by 44 feet and a top of 24 by 17. The outermost section is usually 30 feet above low water, and the inner sections a few feet higher.

The acts of Congress authorizing the construction of ice piers require an antecedent cession of riparian rights in favor of water craft seeking shelter from ice.

Ice pier at Kerr Run, 247 miles below Pittsburg.—Under contract, dated May 23, 1891, with James R. Ware. This ice pier is located at the upper end of the city of Pomeroy, Ohio. At the close of the fiscal year the contractor had not begun work.

Ice pier at Portsmouth, 353 miles below Pittsburg.—This pier has four sections. A contract for an ice pier of three sections was made with

John J. Shipman, under date of September 16, 1889, and one for a fourth section, inside of the others, was made with James R. Ware, under date of May 23, 1891.

The first contract has been completed. The three finished sections contain 174,770 feet, B. M., of timber, 9,092 cubic yards of rock, and 18,138 pounds of iron as bolts, spikes, and mooring rings. At the close of the fiscal year no work had been done on the fourth section, but a small quantity of riprap had been placed by the new contractor to further protect the three completed sections.

Ice pier at Ripley, 414 miles below Pittsburg.—Under contract, dated May 23, 1891, with Jas. R. Ware. At the close of the fiscal year the contractor was about ready to begin work.

EMBANKMENTS.

Great Miami embankment, 489 miles below Pittsburg.—The river and harbor acts of 1886 and 1888 state that the object of this work is to confine the waters of the Great Miami in great floods, "to the end that the formation of the bar in the Ohio River, now forming and obstructing navigation, may be arrested."

The act of September 19, 1890, allotted \$13,250 for the completion of the Great Miami embankment, and at the beginning of the fiscal year there was a residue of \$10,416.08 left over from previous allotments. The next step in continuing the embankment was to raise the track of the Ohio and Mississippi Railroad where it crossed the line of the proposed levee, and a contract for this purpose was made with the railroad company on January 9, 1891, at 40 cents per cubic yard. The total cost of this work, including incidental expenses, was \$8,722.21, leaving \$14,943.87 for additional work.

The next step in order was to extend the levee on the east side of the Ohio and Mississippi Railroad until it reached the point where the levee merged into the roadbed (to be raised) of the Cleveland, Cincinnati, Chicago and St. Louis Railway. A contract for this work was let on the 10th of June, 1891, to John Johnson. At the close of the fiscal year no work has been done under the last-named contract.

Embankment at Shawneetown, 848 miles below Pittsburg.—The object of this work is stated in the river and harbor act to be "the preservation of the harbor," and the work to be done is to strengthen the existing levee by additional earth, and to protect the exposed faces by riprap or paving.

A contract for the necessary amount of earth was made with the Ohio and Mississippi Railway Company, under date of January 19, 1891, and at the close of the fiscal year this contract had been completed, by the delivery of 11,450 cubic yards of earth. The total cost of this work, including inspection and incidental expenses, was \$3,313.24, leaving \$11,690.25 which is to be applied to riprap and paving. No contract for the last named work has yet been let.

BIG HOCKING RIVER.

This river enters the Ohio at a point 197 miles below Pittsburg and 14 miles below Parkersburg. The work of improving navigation on this stream is paid for out of the appropriation for the improvement of the Ohio River, and it therefore appears under that heading. The object to be attained is to permit Ohio River steamboats to ascend to Coolville, 5 miles above the mouth, during high and medium stages of the Ohio, taking advantage of the back water.

During the past fiscal year 450 cubic yards of rock and several logs and stumps were removed from the channel.

DREDGING IN 1890.

At the close of 1889 the Ohio River dredges were in winter quarters at Marietta. Owing to the exhaustion of Ohio River funds, they had to remain idle until the passage of the river and harbor act on September 19, 1890. As the *Oswego* was ready for work, she was employed in graveling the dam at the head of Marietta Island and in helping at the Ice Harbor lock while some minor repairs were being made on the *Ohio*. On the 4th of October both dredges began work at the foot of Blennerhassett Island, where they remained until November 11. During this period there was a constant succession of rises, and the dredges could only get in 3 days' work, and in this brief period they cracked two spuds and twisted one dipper pole. As there appeared no prospect of water low enough to permit dredging, they were finally ordered into winter quarters at Marietta, where they arrived on November 13 and the scows and flats on the 14th.

Under these exceptional circumstances it was deemed unnecessary to prepare the customary table of expenditures.

Dump scows.—Under contract dated April 14, 1891, with S. W. Coffin & Son. As the dump scows of the dredging fleet are worn out, designs were prepared for two new scows, introducing the novel feature of longitudinal trusses of steel, extending the whole length of the hold. Experience has demonstrated that the chief cause of the frequent repairs of dump scows and their early deterioration is the lack of longitudinal stability, and it is hoped that the increased durability of the new scows, and the saving on repairs, will more than justify the increased cost of construction. At the close of the fiscal year these scows were completed. The contract price for the two, including delivery at Pittsburg, is \$7,074.

Further details are given in the following report of Mr. E. J. Carpenter, C. E., superintendent of dredging.

REPORT OF MR. E. J. CARPENTER, ASSISTANT ENGINEER.

The dredges spent the winter of 1889-'90 in the mouth of the Muskingum River, and as there was no money available at the usual time for resumption of work, they remained in the neighborhood of Marietta until after the passage of the river and harbor act on September 19.

As the *Ohio's* boiler was worn out, a new one was ordered and built before the passage of the appropriation bill. Preparations were also made so that the boats might be put in working order as quickly as possible.

From July 15 to August 28 the *Oswego* was employed at the old Harmar Lock, to pump out the coffer dam and for other purposes, but the expense of this was paid out of funds belonging to the Muskingum River.

As money for the Ohio River became available late in the season, it was decided to make only such repairs to the dredges as were absolutely indispensable, postponing the other repairs until the following year.

The *Oswego* was ready for work in September, before the *Ohio*, and was employed in backing with gravel the dam at the head of Marietta Island. After the repairs of the *Ohio* and the scows were finished, further dredging was done about the Harmar Lock September 29–October 3, and on October 4 the dredges proceeded to the foot of Blennerhassett Island, where they resumed the work of removing the old wing dam on the Ohio side of the channel. On the following day the river had risen so much as to compel the dredges to leave the dike, and until November 10 it remained too high to permit any excavation. The dredges made several attempts to resume work at times when the river fell to within a few feet of the highest stage at which work was possible, but they could not be held in place.

On November 10 the river had again fallen, and although it was still too high to work in safety, dredging was resumed and a small amount of work was done. On the 11th the *Oswego* cracked a spud in consequence of working in the strong current and deep water, and the *Ohio* also cracked a spud and had her dipper pole badly twisted. As the river had begun to rise rapidly, and there was no prospect that it would fall so that dredging could be resumed for at least a couple of weeks, the

dredges were taken back to Marietta, where, after widening the channel at the mouth of the Muskingum sufficiently to secure harbor room, they were laid up for the winter.

The total expenditure for the dredging fleet in 1890 was \$11,284.22.

Dam at head of Marietta Island, 168 miles below Pittsburg.—Dredging at this point was for the purpose of supplying gravel to bank against the dam which closes the West Virginia channel, the work being done by the Oswego while the Ohio was undergoing repairs.

Material from the bar at the head of Marietta Island was loaded into scows, which were dumped as closely as possible above the dam. A portion of this material was afterwards banked against the dam by the dredge. Excavation made September 9-11, and September 26 to October 1, 6,813 cubic yards.

Dam No. 1, Muskingum River.—The dredges were employed to furnish spoil for use in building a coffer at the lower end of the old Harmar Lock, and also to supply gravel for use in making concrete. Excavation made September 29 to October 3, 1,727 cubic yards.

Harmar, Ohio, 171 miles below Pittsburg.—The dredges removed from the channel below the dike at the foot of Marietta Island two wrecks of coal boats in July, and one wrecked coal flat, and one snag weighing two tons, on September 25.

Foot of Blennerhassett Island, 188 miles below Pittsburg.—The object of this dredging was to complete the removal of the old wing dam on the Ohio shore, on which work the dredges had been employed in 1888 and 1889.

As previously stated, continuous high water prevented the dredges from doing more than 3 days' work in over a month, and it seemed inadvisable to attempt anything further under these circumstances. Excavation made, October, 4,262 cubic yards; November 10, 11, 1,950 cubic yards. Total, 2,212 cubic yards.

WORK OF SNAG BOAT IN 1890.

As the last river and harbor act made the expenses of the Ohio River snag boat a permanent charge on the Treasury, the operations of this boat will hereafter appear in the Annual Report under a separate heading.

HARBOR LINES.

Under the authority conferred by section 12 of the river and harbor act of September 19, 1890, the Secretary of War has ordered that harbor lines be established at Pittsburg, Wheeling, and Cincinnati. A Board of Engineers has been appointed to recommend harbor lines for adoption, and on the recommendation of the Board surveys of the harbors of these three cities are now in progress under charge of this office, with a view to the acquirement of the necessary data.

NEW BRIDGES OVER THE OHIO RIVER.

During the past fiscal year this office has been charged with the duty of supervising the erection of the following bridges:

Ohio Connecting Railway Bridge, crossing the Ohio River at Brunot Island, 2 miles below Pittsburg. This bridge was completed in November in full accordance with the plans approved by the Secretary of War.

Bridge of Wheeling Bridge and Terminal Railway Company, crossing the Ohio River at Wheeling, 89 miles below Pittsburg. This bridge was completed in November, in full accordance with the plans approved by the Secretary of War.

Bridge of Wheeling Bridge Company, at Wheeling, W. Va., 90 miles below Pittsburg. This bridge crosses the Ohio River 280 feet below the Suspension Bridge. At the close of the fiscal year all of the piers were completed and the superstructure east of the channel span.

Bridge of West Virginia and Ironton Railroad Company, at Kenova, Ky., 313 miles below Pittsburg. This bridge is still under construction.

Bridge of the Central Bridge Company, between Newport and Cincinnati, 466 miles below Pittsburg. At the close of the fiscal year the superstructure was in place on the whole bridge, except the northern half of the cantilever and the northern anchoring span.

STAGES OF THE OHIO RIVER DURING 1890-'91.

The summer and autumn of 1890 was remarkable for the steady continuance of navigable water, which made it a remarkably favorable season for river commerce, but an equally unfavorable season for all work to be done in the bed of the river. The following are the records of the gauges at Pittsburg, Cincinnati, and Evansville, which may be taken to represent the navigable condition of the Upper, Middle, and Lower Ohio.

Gauge at Davis Island Dam, near Pittsburg.—When the dam is up low-water readings must be obtained from the gauge at the lower end of the lock. On this gauge 3 feet 2 inches corresponds to a navigable depth of 3 feet, and 6 feet corresponds to the same depth in the river.

Davis Island Dam.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
1890.	<i>Days.</i>	<i>Days.</i>	<i>Days.</i>	<i>Feet.</i>	<i>Feet.</i>
July	16	15	1	6.3	2.2
August	15	16	9	9.2	2.3
September	0	30	21	15.0	3.4
October	0	31	31	15.5	6.4
November	0	30	28	12.7	5.9
December	0	31	17	11.0	5.0
1891.					
January	0	31	31	21.8	6.9
February	0	28	28	30.0	10.1
March	0	31	31	13.8	7.8
April	0	30	26	14.4	4.9
May	4	27	24	5.9	2.9
June	0	30	21	11.8	4.4
Total	35	330	245		

Cincinnati gauge.—The zero of this gauge is about 2 feet below low water; readings of 4 feet correspond to about 3 feet in the channel, and those of 7 feet to about 6 feet in the channel.

Cincinnati.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
1890.	<i>Days.</i>	<i>Days.</i>	<i>Days.</i>	<i>Feet.</i>	<i>Feet.</i>
July	0	31	25	19.0	6.6
August	0	31	22	20.8	5.8
September	0	30	30	35.2	11.1
October	0	31	31	32.9	12.0
November	0	30	30	31.5	16.5
December	0	31	31	31.5	12.3
1891.					
January	0	31	31	48.7	21.0
February	0	28	28	57.3	33.6
March	0	31	31	50.3	32.2
April	0	30	30	43.5	15.5
May	0	31	31	14.7	7.9
June	0	30	30	24.5	13.7
Total	0	365	350		

Evansville gauge.—The zero of this gauge is at the low-water line. Readings of 2 feet correspond to about 3 feet in the channel, and readings of 6 feet correspond to about 6 feet in the channel.

Evansville.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
1800.	<i>Days.</i>	<i>Days.</i>	<i>Days.</i>	<i>Feet.</i>	<i>Feet.</i>
July.....	0	31	30	14.0	5.9
August.....	0	31	18	11.0	4.6
September.....	0	30	30	24.9	8.6
October.....	0	31	31	21.8	8.9
November.....	0	30	30	28.5	14.5
December.....	0	31	31	26.9	9.3
1801.					
January.....	0	31	31	37.3	18.4
February.....	0	28	28	42.6	26.0
March.....	0	31	31	42.8	32.6
April.....	0	30	30	37.3	15.8
May.....	0	31	31	14.8	6.2
June.....	0	30	30	17.6	6.5
Total.....	0	365	351	.....	.....

Comparing these records with those of previous years, we find that the season of 1890-91 was remarkable for the abundant supply of water during the summer and autumn, being the periods during which low water is confidently expected. The tables show conclusively why it was difficult to complete contracts for river work.

OPERATION OF DRAWS IN HIGH BRIDGES.

There are no low drawbridges on the Ohio River; the general Ohio River bridge law requires that all bridges shall have a height of at least 40 feet above high water, and, since large steamboats require more room than 40 feet, it is also provided that all bridges below the Cincinnati suspension bridge shall have a draw for use in high water unless they give a clearance of at least 53 feet above high water. There are three high-water draws on the Ohio River, but the draw in the Ohio Falls Bridge at Louisville is exceptionally located, and no records of its operation is kept. The other two draws were operated for the benefit of navigation, as follows:

	Cincinnati Southern.	Kentucky and Indiana.
	<i>Days.</i>	<i>Days.</i>
February, 1891.....	0	17
March, 1891.....	0	4
Total.....	0	21

STOPPAGE OF NAVIGATION BY ICE.

The past winter was a very mild one, and assuming, as heretofore, that the condition of affairs at Cincinnati is a fair average for the whole river, I have to report that the navigation of the Ohio River was not affected by ice during the past fiscal year.

LOSSES BY COLLISION WITH BRIDGES.

The following tables show the losses sustained by the commerce of the Ohio River during the past fiscal year by collision with the piers of bridges crossing the Ohio River.

Beaver Bridge.

[Completed in 1878.]

Date.	Owners.	Steamboat.	Loss.	Amount.
June 8, 1891	Tennessee River Navigation Company.	Iron Age	1 flat	\$450
	Previously reported			55,590
	Total			56,040

Wheeling and Martin Ferry Bridge.

[Completed in 1890.]

Date.	Owners.	Steamboat.	Loss.	Amount.
Aug. 1890....	C. Jutte & Co.	Twilight	1 coal boat	\$3,600
	Previously reported			6,200
	Total			\$9,800

Bellaire Bridge.

[Completed in 1871.]

Date.	Owners.	Steamboat.	Loss.	Amount.
Nov. 13, 1890	W. H. Brown's Sons....	Chas. Brown	1 barge, 1 flat	\$2,700
	Previously reported			123,876
	Total			126,576

Parkersburg Bridge.

[Completed in 1871.]

Date.	Owners.	Steamboat.	Loss.	Amount.
Sept. 10, 1890	W. H. Brown's Sons....	Chas. Brown	1 flat	\$500
Dec. 25, 1890	C. Jutte & Co.	Twilight	1 barge	1,425
June 9, 1891	W. H. Brown's Sons....	Chas. Brown	1 barge	2,430
	Total			4,355
	Previously reported			68,322
	Grand total			72,677

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Kenova Bridge.

[Unfinished.]

Date.	Owners.	Steamboat.	Loss.	Amount.
Mar. 1891	Armstrong Bros	Nail City	1 steamboat	\$6,000
Do.....	do	do	2 barges and 1 flat	2,700
	Total			8,700

Newport and Cincinnati Railroad Bridge.

[Completed in 1872.]

Date.	Owners.	Steamboat.	Loss.	Amount.
Mar. 20, 1891	John F. Walton & Co.	John F. Walton	1 coal boat, 1 flat	\$2,000
	Previously reported			42,107
	Total			44,107

Covington and Cincinnati Railroad Bridge.

[Completed in 1889.]

Date.	Owners.	Steamboat.	Loss.	Amount.
Feb. 17, 1891	Thos. Sherlock Trans. Co.	Thos. Sherlock	Steamboat	\$35,000
	Previously reported			8,150
	Total			43,150

Kentucky and Indiana Bridge.

[Completed in 1886.]

Date.	Owners.	Steamboat.	Loss.	Amount.
May 6, 1891	O. P. Shinkle	Golden Rule	Steamboat damaged	\$1,500
Do.....	Cook, Hoffman & Co.	Transit*	Steamboat	20,000
	Total			21,500
	Previously reported			6,267
	Grand total			27,767

* The *Transit* did not strike the bridge, but was lost while helping the *Golden Rule*.

Cairo Bridge.

[Completed in 1889.]

Date.	Owners.	Steamboat.	Loss.	Amount.
Mar. 15, 1891	Sundry parties	Jos. B. Williams	2 boats and 1 barge	\$6,289
	Previously reported			2,953
	Total			9,242

Losses by collision with Ohio River bridges to June 30, 1891.

Beaver Bridge.....	\$56, 040
Steubenville Bridge.....	90, 308
Wheeling and Martin Ferry Bridge.....	9, 800
Bellaire Bridge.....	126, 576
Parkersburg Bridge.....	72, 677
Point Pleasant Bridge.....	9, 600
Kenova Bridge.....	8, 700
Newport and Cincinnati Railroad Bridge.....	44, 107
Covington and Cincinnati Railroad Bridge.....	43, 150
Cincinnati Southern Railroad Bridge.....	9, 812
Ohio Falls Bridge.....	80, 350
Kentucky and Indiana Bridge.....	27, 767
Henderson Bridge.....	18, 480
Cairo Bridge.....	9, 242
Total.....	606, 609

The only completed bridges over the Ohio River which have no record of damages to river craft are the following: Brunot Island Bridge, Wheeling Suspension Bridge, Covington and Cincinnati Suspension Bridge. The first-named bridge was finished in November, 1890.

CHANGES IN THE CHARACTER OF OHIO RIVER COMMERCE.

In connection with the commercial statistics, which are given farther on in this report, I have thought that it would be interesting and valuable to give the views of a well-known authority on statistics on the present condition of Ohio River commerce. I have therefore made the following extracts from the last annual report of Col. S. D. Maxwell, superintendent of the Cincinnati Chamber of Commerce:

To the river interests of the city, with an almost uninterrupted period of navigable water, with increased business, and a general prosperous condition, the past 2 years have furnished a striking contrast with the 2 preceding years, marked as they were by interruptions from ice, low water, and generally unfavorable business features, which were calculated to raise the question in the minds of persons who reasoned within a narrow circle, that the river was waning in its commercial value and had seen its largest usefulness. It is true the business of the river has undergone great changes. The number of boats for the performance of the work has largely diminished; the river no longer furnishes transportation for light merchandise over long distances nor for that which requires quick transport, the railroads, from the very logic of the situation, having absorbed much business which represented the kind performed by the river many years ago; but they who suppose that the navigable waters of the interior have practically completed their work fail to recognize the fact that more freight is now furnished by heavy articles of merchandise, especially suited to transportation by water, including fuel, which is transported in barges, than constituted the entire business of the river in those days when it was the sole method of transportation throughout the West; they forget that the single article of coal, than which nothing sustains a more intimate relation to the industrial prosperity of the interior, has furnished annually, in the past 3 years, for Cincinnati alone, an average annual tonnage of 2,450,574, or more than twice the total average annual tonnage, as near as can be ascertained, of all the boats arriving at Cincinnati during the 13 years preceding 1860-'61, which represent the palmiest days of steamboating in the West, assuming that every boat during that period arrived at our wharves loaded to its full capacity as indicated by its official measurement, with 36 per cent. added to make good the excess of carrying capacity over hull measurement; they also forget that the average vessel in our time represents the performance of a much larger amount of work, inasmuch as it is generally of greater carrying capacity, and that the time of making trips between given points has been materially reduced; they are also unmindful of the fact that while we are prone in this country to underestimate the importance of water transportation as a competitive agency, other nations, with a larger foresight, are zealously developing their system of internal water ways. The business in each of the past 2 years has not alone been characterized by large receipts of coal, but the general business has been more satisfactory and remunerative than during a number of preceding

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years, so that, at times, with the inability to procure new boats in time for meeting the demand, the boats in use have been unequal to providing for the actual wants of the trade, the insufficiency of capacity having been especially apparent in the Memphis and New Orleans trades. While the increased business has been generally exhibited, it has been particularly noticeable in the Pittsburg and Cincinnati trade, which has been the best in years. It is probably true that this increase is largely traceable to favorable conditions of the river, but, however this may be, it furnishes a powerful argument for us to do all that can be done toward improving the navigable character of the stream and its tributaries, and thus lengthen, as far as possible, the navigable period.

ESTIMATE.

The following estimate is submitted as my judgment of the amount of money that should be appropriated to a river of the magnitude of the Ohio and with so large and valuable a commerce:

Low dams and dikes	\$600, 000
Davis Island Dam	11, 500
Rock bar at mouth of Licking River	20, 000
Dredging	20, 000
Removal of rock reefs in channel	20, 000
General administration, inspection, engineering, and contingencies	35, 000
Total	706, 500

The item of \$11,500 inserted for the Davis Island Dam is composed of \$3,500 for quarters on Davis Island and \$8,000 for extending the guide crib below the land wall of the lock. Experience after the work was completed showed that more men were required to manage the lock and dam than were originally estimated for, and it became necessary to quarter the additional force on Davis Island. They were placed in the temporary buildings occupied by the laboring force during the construction of the work, but these buildings are no longer habitable. The extension of the guide crib below the lock is urgently requested by coal shippers, because at certain stages of the river there is an eddy below the lock, and an hour or two is sometimes lost before a fleet can get out of this eddy and proceed down the river.

Money statement.

July 1, 1890, balance unexpended	\$136, 648. 06
Amount appropriated by act approved September 19, 1890	300, 000. 00
	<hr/>
June 30, 1891, amount expended during fiscal year	436, 648. 06
	119, 590. 96
July 1, 1891, balance unexpended	317, 057. 10
July 1, 1891, outstanding liabilities	\$9, 240. 86
July 1, 1891, amount covered by uncompleted contracts	169, 579. 29
	<hr/>
	178, 820. 15
July 1, 1891, balance available	138, 236. 95
	<hr/>
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	706, 500. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for constructing dams and dikes in the Ohio River, opened January 22, 1891.

CRIB SUPERSTRUCTURE ON DIKE AT FOOT OF MARIETTA ISLAND.

No.	Name and address of bidder.	Oak timber, per thousand.	Driftbolts, per pound.	Spikes, per pound.	Riprap stone, per cubic yard.	Paving, per square.	Total.
			<i>Cents.</i>	<i>Cents.</i>			
1	John C. Graham, Gallipolis, Ohio	\$20.00	6	7	\$0.98	\$2.50	\$6,572
2	Josiah T. Hart, Marietta, Ohio	20.00	4	4	1.25	1.25	6,909
3	John J. Shipman, Washington, D. C.	24.00	4	8	1.10	1.75	7,021
4	William A. McCosh, Parkersburg, W. Va.	26.50	5	5	1.00	1.50	7,060
5	Richardson & Monroe, Portsmouth, Ohio	23.00	4½	8	1.00	5.00	7,126
6	I. V. Hoag, jr., Pittsburg, Pa.	24.00	3	3	1.20	2.00	7,198
7	Oliver Reed, Water Cure, Pa.	28.50	5	5	1.45	2.75	8,885
8	Garrett T. Fogel, Allegheny, Pa.	28.00	5	8	1.60	3.00	9,328
9	William Walter, Fulton, N. Y.	35.00	5	4½	1.25	16.00	10,917

Contract awarded to John C. Graham, and executed under date of February 14, 1891.

DAM AT HEAD OF BLENNERHASSETT ISLAND.

No.	Name and address of bidder.	Oak timber, per thousand.	Pine or hemlock, per thousand.	Driftbolts, per pound.	Spikes, per pound.	Split bolts, etc., per pound.	Riprap stone, per cubic yard.	Paving, per square.	Total.
				<i>Cents.</i>	<i>Cents.</i>	<i>Cents.</i>			
5	Richardson & Monroe, Portsmouth, Ohio	\$21.00	\$20.00	4½	8	7	\$0.95	\$4.00	\$21,685.00
10	J. W. Gardner, Gallipolis, Ohio	24.25	24.25	4	4	6	.93	1.75	21,783.75
1	John C. Graham, Gallipolis, Ohio	20.00	20.00	6	7	7	.99	2.50	21,972.00
3	John J. Shipman, Washington, D. C.	24.00	20.00	4	6	8	.99	1.75	22,067.50
4	Wm. A. McCosh, Parkersburg, W. Va.	25.00	20.00	5	5	6	1.00	1.50	22,666.00
6	I. V. Hoag, jr., Pittsburg, Pa.	24.00	21.50	3	3	7	1.15	2.00	22,773.00
11	Leaphier Cramer, Parkersburg, W. Va.	28.50	27.00	4½	5	6	1.00	2.00	24,107.00
2	Josiah T. Hart, Marietta, Ohio	22.50	22.50	4	4	8	1.22	1.50	24,421.00
8	Garrett T. Fogel, Allegheny, Pa.	28.00	24.00	5	8	7	1.60	3.00	31,529.00
9	William Walter, Fulton, N. Y.	35.00	30.00	5	4½	15	1.25	16.00	33,881.00

Contract awarded to Richardson & Monroe, and executed under date of February 14, 1891.

DIKE AT CULLUMS.

No.	Name and address of bidder.	Tiles, each.	Brush, per cord.	Riprap stone, per cubic yard.	Total.
3	John J. Shipman, Washington, D. C.	\$2.00	\$0.85	\$0.85	\$19,850.00
12	Frederick Hartweg, Dayton, Ky.	2.25	1.25	.94	23,615.00
5	Richardson & Monroe, Portsmouth, Ohio	2.74	1.47	.85	24,065.60
13	James R. Ware, Cincinnati, Ohio	2.75	1.25	.95	24,435.00
14	Henry C. Jones, Mt. Vernon, Ind.	2.50	1.25	1.18	27,550.00
6	I. V. Hoag, jr., Pittsburg, Pa.	2.50	2.00	1.50	45,900.00
15	Martin Harrell & Co., Cleves, Ohio	8.00	2.50	1.60	47,720.00

Contract awarded to John J. Shipman, and executed under date of February 9, 1891.

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DIKE AT LOWER BAR, RISING SUN, IND.

No.	Name and address of bidder.	Tiles, each.	Brush, per cord.	Riprap stone, per cubic yard.	Total.
3	John J. Shipman, Washington, D. C.	\$2.00	\$0.85	\$0.88	\$15,580.00
16	William Kirk, Madison, Ind.	2.00	80	90	15,610.00
12	Frederick Hartweg, Dayton, Ky.	2.25	1.15	88	17,037.50
14	Henry C. Jones, Madison, Ind.	2.10	1.10	94	17,373.00
13	James R. Ware, Cincinnati, Ohio.	2.75	1.25	95	18,767.50
5	Richardson & Monroe, Portsmouth, Ohio.	2.85	1.50	90	19,285.50
6	I. V. Hoag, jr., Pittsburg, Pa.	2.50	2.00	1.50	27,825.00

Contract awarded to John J. Shipman, and executed under date of February 9, 1891.

CRIB SUPERSTRUCTURE ON DIKE AT MADISON, IND.

No.	Name and address of bidder.	Oak timber, per M.	Pine or hemlock, per M.	Drift-bolts, per pound.	Spikes, per pound.	Riprap stone, per cubic yard.	Paving, per square.	Total.
16	William Kirk, Madison, Ind.	\$25.00	\$25.00	<i>Cents.</i> 5	<i>Cents.</i> 5	\$1.00	\$2.00	\$10,975.00
6	I. V. Hoag, jr., Pittsburg, Pa.	25.00	23.00	3	3	1.40	2.00	12,349.00

Contract awarded to William Kirk, and executed under date of February 14, 1891.

DIKE AT FLINT ISLAND.

No.	Name and address of bidder.	Piles, each.	Brush, per cord.	Riprap stone, per cubic yard.	Total.
16	William Kirk, Madison, Ind.	\$1.75	\$0.80	\$0.85	\$25,079.90
3	John J. Shipman, Washington, D. C.	1.75	.80	.89	25,869.90
12	Frederick Hartweg, Dayton, Ky.	2.25	.95	.84	26,984.44
14	Henry C. Jones, Madison, Ind.	2.00	.94	.90	28,029.82
17	Eigenmann & Hollerback, Rockport, Ind.	2.10	.90	.95	28,322.70
13	James R. Ware, Cincinnati, Ohio.	2.25	.90	.98	29,170.20
5	Richardson & Monroe, Portsmouth, Ohio.	2.90	1.50	.55	31,854.50
6	I. V. Hoag, jr., Pittsburg, Pa.	2.50	2.00	1.20	41,881.00

Contract awarded to William Kirk and executed under date of February 14, 1891.

Abstract of proposals for towboat for service with Ohio River dredges, opened September 9, 1890.

No.	Name and address of bidder.	Steamboat.	Price per day.
1	J. P. Capehart, Syracuse, Ohio.	J. M. Clark.	\$28.50
2	Val. P. Collins, Cincinnati, Ohio.	George W. Stone.	43.44
3	Varian Transportation Company, Letart, W. Va.	Bob. Ballard.	44.00
4	Tide Coal Company, Pittsburg, Pa.	Little Bill.	45.00
5	S. D. Davis, Marietta, Ohio.	J. H. McConnell.	46.00
6	A. Montgomery & Co., Cincinnati, Ohio.	Al. Martin.	49.33

Contract awarded to Val. P. Collins and executed under date of September 19, 1890.

Abstract of proposals for raising roadbed of Ohio and Mississippi Railway to height of levee at Lawrenceburg, Ind.

No.	Bidder.	Earth filling per cubic yard.	Total.
1	Ohio and Mississippi Rwy. Co.....	\$0.40	\$8,611.96

Contract awarded to Ohio and Mississippi Railway Company, and executed under date of January 9, 1891.

Abstract of proposals for the construction of two dump scows for use with Ohio River dredges, opened March 9, 1891.

No.	Name and address of bidder.	Price per scow.	Total.
1	S. W. Coffin & Son, Cincinnati, Ohio	\$3,537.00	\$7,074.00
2	David K. Sprinkle, Cincinnati, Ohio.....	4,145.00	8,290.00
3	M. A. Sweeney & Bro., Jeffersonville, Ind.....	5,300.00	10,600.00

Contract awarded to S. W. Coffin & Son, and executed under date of April 14, 1891.

Abstract of proposals for extending embankment on south side of Great Miami River, opened June 1, 1891.

No.	Name and address of bidder.	Price per cubic yard.	Total.
		<i>Cents.</i>	
1	John Johnson, Crawfordsville, Ind	21½	\$7,310.00
2	Guthrie Brothers, Plymouth, Ohio.....	22½	7,616.00
3	John W. Scott & Co., Aurora, Ind	23	7,820.00
4	George W. Murdock & Co., Aurora, Ind	26	8,840.00
5	J. J. Rumsay, Fosteria, Ohio.....	28½	9,690.00
6	Annis, Lowe & McElfresh, Lawrenceburg, Ind	30	10,200.00
7	John J. Shipman, Cincinnati, Ohio	33½	11,338.33
8	William Z. Partello, Washington, D. C.....	35	11,900.00
9	B. D. Barton, Cincinnati, Ohio.....	41	13,240.00
10	John M. Bolan, Cincinnati, Ohio	45	15,300.00

Contract awarded to John Johnson, and executed under date of June 10, 1891.

Abstract of proposals for delivering earth on embankment at Shawneetown, Ill.

No.	Bidder.	Earth filling per cubic yard.	Total.
1	Ohio and Mississippi Rwy. Co.....	\$0.25	\$2,862.50

Contract awarded to Ohio and Mississippi Railway Company, and executed under date of January 19, 1891.

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Abstract of proposals for constructing ice piers in the Ohio River, opened May 15, 1891.

ICE PIER AT PORTSMOUTH, OHIO.

No.	Name and address of bidder.	Oak timber per M.	Riprap stone per cubic yard.	Drift bolts per pound.	Mooring rings per pound.	Total.
				<i>Cents.</i>	<i>Cents.</i>	
1	Jas. R. Ware, Cincinnati, Ohio.....	\$19.50	\$0.80	7	9	\$3,747.09
2	John J. Shipman, Riverside, Ohio.....	19.00	.88	4	8	3,754.45
3	Henry C. Jones, Madison, Ind.....	24.00	1.15	5	5	4,908.85
4	Richardson & Monroe, Portsmouth, Ohio.....	25.00	1.15	7	7	4,968.12

Contract awarded to Jas. R. Ware, and executed under date of May 23, 1891.

ICE PIER AT RIPLEY, OHIO.

No.	Name and address of bidder.	Oak timber per M.	Riprap stone per cubic yard.	Drift bolts per pound.	Mooring rings per pound.	Total.
				<i>Cents.</i>	<i>Cents.</i>	
1	Jas. R. Ware, Cincinnati, Ohio.....	\$19.50	\$0.74	7	9	\$4,289.62
2	John J. Shipman, Riverside, Ohio.....	21.00	.95	4	8	4,661.16
5	John Taylor, Jr., Higginsport, Ohio.....	24.00	.80	5	8	4,713.90
4	Richardson & Monroe, Portsmouth, Ohio.....	24.00	1.10	4½	6	5,278.03
3	Henry C. Jones, Madison, Ind.....	25.00	1.15	5	5	5,499.10

Contract awarded to Jas. R. Ware, and executed under date of May 23, 1891.

ICE PIER AT KERR RUN.

No.	Name and address of bidder.	Oak timber per M.	Riprap stone per cubic yard.	Drift bolts per pound.	Mooring rings per pound.	Total.
				<i>Cents.</i>	<i>Cents.</i>	
1	James R. Ware, Cincinnati, Ohio.....	\$19.50	\$0.85	7	9	\$4,526.78
6	John Pepple, Gallipolis, Ohio.....	23.00	1.10	5	8	5,258.70
4	Richardson & Monroe, Portsmouth, Ohio.....	24.00	1.10	4½	6	5,278.03
7	B. J. Malone, Pomeroy, Ohio.....	30.00	.99	8	3½	5,488.16

Contract awarded to James R. Ware, and executed under date of May 23, 1891.

Abstract of proposals for furnishing steamboat for service as dredge-boat tender, opened June 6, 1891.

No.	Name and address of bidder.	Steamboat.	Price per day.
1	J. P. Capehart, Syracuse, Ohio.....	J. W. Clark.....	\$37.00
2	Huling Bros., Pittsburg, Pa.....	Bob Connell.....	41.50
3	S. D. Davis, Marietta, Ohio.....	J. H. McConnell.....	43.00
4	Steamer Delta and owners, Pittsburg, Pa.....	Delta.....	44.50
5	Tide Coal Company, Pittsburg, Pa.....	Little Bill.....	45.00
6	A. Montgomery & Co., Cincinnati, Ohio.....	Al. Martin.....	54.74

Contract awarded to S. D. Davis, and executed under date of June 19, 1891.

Abstract of contracts for improving Ohio River, in force during the fiscal year ending June 30, 1891.

Contractor.	Work of improvement.	Date.	To expire.
Josiah T. Hart.	Dam at head of Marietta Island.	Feb. 9, 1889	Dec. 31, 1889*
John C. Graham	Dike at foot of Marietta Island	Feb. 14, 1891	Dec. 31, 1891
Richardson & Monroe	Dam at head of Blennerhassett Island	do	Do.
John J. Shipman.	Dike at Eight-mile Island	Feb. 9, 1889	Dec. 31, 1889†
Do.	Dike at Bonanza Bar	do	Do.
Do.	Dike at Cullom Ripple	Feb. 9, 1891	Dec. 31, 1891
Do.	Dike at lower bar, Rising Sun, Ind.	do	Do.
William Kirk	Substructure of dike at Madison, Ind.	Feb. 9, 1889	Dec. 31, 1889†
Do.	Superstructure of dike at Madison, Ind.	Feb. 14, 1891	Dec. 31, 1891
Do.	Dike at Flint Island	do	Do.
Do.	Dike at Caseyville	Feb. 9, 1889	Dec. 31, 1889*
I. V. Hong, Jr.	Dike at Grand Chain.	Dec. 1, 1884	Dec. 1, 1885†
John F. King	Removing rock bar at mouth of Licking River	July 12, 1889	Dec. 31, 1889‡
John J. Shipman.	Ice pier at Portsmouth, Ohio.	Sept. 16, 1889	Do.*
Val P. Collins	Towboat for service with dredges in 1890.	Sept. 19, 1890	Dec. 31, 1890||
S. D. Davis.	Towboat for service with dredges in 1891.	June 19, 1891	Dec. 31, 1891
Ohio and Mississippi Ry. Co.	Embankment at Lawrenceburg, Ind.	Jan. 9, 1891	July 29, 1891||
John Johnson	Embankment at Lawrenceburg, Ind.	June 10, 1891	Dec. 1, 1891
S. W. Coffin & Son	Two dump scows for use with dredges.	Apr. 14, 1891	June 10, 1891†
Ohio and Mississippi Ry. Co.	Embankment at Shawneetown, Ill.	Jan. 19, 1891	June 30, 1891||
James K. Ware	Ice pier at Portsmouth, Ohio.	May 23, 1891	Dec. 31, 1891
Do.	Ice pier at Ripley, Ohio	do	Do.
Do.	Ice pier at Kerr Run, Ohio	do	Do.

* Extended to December 31, 1890, and completed.

† Extended to December 31, 1891.

‡ Extended to December 31, 1891, and completed.

§ Contract abandoned.

|| Completed.

¶ Extended to June 30, 1891, and completed.

COMMERCIAL STATISTICS.

In preparing the following statistics it has been thought best to follow the calendar instead of the fiscal year, as it is impracticable to gather statistics in the limited period available after the close of the fiscal year, and the calendar year is in general use among statisticians. In carrying out this system it has been necessary, where the commercial movement of several years is compared, to recompile on the new basis several tables that have heretofore accompanied this report. This will account for any apparent discrepancies.

Coal shipments from Pittsburg.

[Furnished by Capt. Wm. Evans.]

Months.	To Cincinnati.					To Louisville.				
	Trips.	Coal boats.	Coal barges.	Fuel flats.	Tons.	Trips.	Coal boats.	Coal barges.	Fuel flats.	Tons.
1890.										
January	26	10	360	12	174,463	33	129	284	30	264,647
February	21	7	260	1	149,377	36	183	244	19	294,219
March	21	25	219	3	126,477	49	185	378	13	371,755
April	24	27	284	1	151,954	35	156	237	33	265,282
May	22	18	172	15	139,207	26	47	337	7	172,066
June	12	11	131	32	71,702	13	19	128	17	82,228
July										
August	14		172	8	83,572	13	13	140	15	81,988
September	14	16	141	1	86,853	11	45	90	12	86,978
October	17	12	187		101,153	18	45	164	16	123,893
November	22	21	232	10	134,218	25	70	242	7	182,876
December	17	4	217		105,663	19	91	144	19	169,784
Total	210	151	2,381	83	1,324,641	278	983	2,388	188	2,095,716
Grand total										3,420,357

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Comparative table showing coal shipments from Pittsburg during the seven years ending December 31, 1890.

Year.	To Cincinnati.	To Louisville.	Total.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
1884.....	946, 124	1, 160, 292	2, 106, 416
1885.....	1, 733, 104	1, 114, 008	2, 847, 112
1886.....	1, 262, 702	2, 220, 530	3, 483, 232
1887.....	788, 090	1, 367, 012	2, 155, 702
1888.....	1, 950, 882	2, 223, 494	4, 174, 376
1889.....	1, 149, 892	1, 439, 747	2, 589, 639
1890.....	1, 324, 641	2, 095, 716	3, 420, 357

Commerce passing the Davis Island Dam in 1890.

Vessels.	Ascending.				Descending.				Total freight.
	Through lock.	Freight	Through pass.	Freight	Through lock.	Freight	Through pass.	Freight	
	<i>No.</i>	<i>Tons.</i>	<i>No.</i>	<i>Tons.</i>	<i>No.</i>	<i>Tons.</i>	<i>No.</i>	<i>Tons.</i>	<i>Tons.</i>
Packets.....	19	2, 065	643	66, 696	20	2, 335	659	63, 604	134, 100
Freight boats.....			7	350					350
Towboats.....	82		1, 828		98		1, 829		
Model barges.....			88		1	950		86, 450	87, 400
Coal boats.....	7		522		7	6, 384	1, 330	1, 212, 960	1, 219, 344
Coal barges.....	159		4, 346		31	16, 492	5, 096	1, 711, 072	2, 727, 564
Coal flats.....	114		1, 669		186	28, 272	2, 259	342, 368	371, 640
Rafts.....	1	25	9	240	8	230	91	2, 755	3, 270
Miscellaneous.....	8	220	112	2, 900	13	364	114	2, 296	6, 780
Total.....	390	2, 310	9, 224	69, 586	364	55, 047	11, 469	4, 423, 505	4, 550, 448

It will be noticed that the record at the Davis Island Dam gives a larger tonnage of coal than appears in the statement prepared by Captain Evans. It is possible that some shipments escaped the notice of the latter, as it is almost impossible to secure perfect accuracy.

I am indebted to the courtesy of Col. Sidney D. Maxwell, Superintendent of the Cincinnati Chamber of Commerce, for the following complete tables of the receipts and shipments by river at Cincinnati, in which, however, all the quantities have been transformed into tons by using average weights.

River commerce of Cincinnati for the year ending August 31, 1890.

Articles.	Receipts.	Shipments.	Total.	Articles.	Receipts.	Shipments.	Total.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>		<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Alcohol.....		73	73	Eggs.....	847	16	863
Ale and beer.....		1, 169	1, 169	Feathers.....		3	3
Apples.....	4, 668	326	4, 994	Fish.....		641	641
Bagging.....		19	19	Flour.....	84	4, 125	4, 966
Barley.....		48	48	Fruit.....			
Beans.....		102	102	Dried.....		22	22
Beef.....		11	11	Green.....		25	25
Boots and shoes.....		365	365	Furniture.....		944	944
Bran and middlings.....		822	822	Glass, window.....		186	186
Brooms.....		53	53	Glassware.....	4, 760	3, 173	7, 933
Broom corn.....		5	5	Grease.....		196	196
Butter.....		5	5	Hardware.....		2, 319	2, 319
Candles.....		56	56	Hay.....	4, 427	488	4, 915
Castings.....		1, 795	1, 795	Hides.....		128	128
Cattle.....	3, 219	344	3, 563	Hogs.....	6, 400	55	6, 455
Cement.....	6, 501	2, 217	8, 808	Hog products.....		2, 641	2, 641
Chairs.....		113	113	Hops.....		16	16
Cheese.....		80	80	Horses.....		652	652
Cider.....		363	363	Iron and steel.....	13, 197	10, 170	23, 367
Coffee.....		182	182	Iron.....			
Cooperage.....		1, 400	1, 400	Pig.....	2, 364	6, 732	9, 096
Corn.....	1, 691	1, 140	2, 833	Scrap.....		4	4
Corn meal.....		1, 048	1, 048	Lead.....			
Cotton, bales.....	16, 734	557	17, 291	Pig.....		13	13
Crockery.....		525	525	White.....		374	374

River commerce of Cincinnati for the year ending August 31, 1890—Continued.

Articles.	Receipts.	Shipments.	Total.	Articles.	Receipts.	Shipments.	Total.
	Tons.	Tons.	Tons.		Tons.	Tons.	Tons.
Leather		82	82	Seed, clover and timothy		587	587
Lemons		64	64	Sheep	1,194	52	1,246
Lime		890	890	Shot		351	351
Malt		352	352	Soap		539	539
Manufactures		272	272	Spices		14	14
Merchandise	20,000	30,086	50,086	Starch		434	434
Molasses	3,630	2,000	5,630	Sugar	564	2,173	2,737
Nails	33,001	19,918	53,909	Tallow		5	5
Oats		324	324	Tea		8	8
Oil	1,082	1,439	2,521	Tobacco	17,541	2,618	20,159
Onions		47	47	Turpentine		19	19
Oranges		154	154	Vegetables		266	266
Peanuts	4,587	443	5,030	Vinegar		1,034	1,034
Petroleum	1,189	1,460	2,649	Wheat	3,883	1,308	5,191
Potatoes	5,993	837	6,830	Whisky	9,167	6,010	15,177
Rice		110	110	Wines and liquors		125	125
Rope and twine		277	277	Wool		76	76
Rosin		41	41				
Rye		67	67				
Salt	26,320	14,606	40,926	Total	194,882	134,829	329,711

The following tables, compiled from Colonel Maxwell's annual report, furnish additional information concerning the river commerce of Cincinnati:

Arrivals and departures of steamboats at the port of Cincinnati.

Ports.	1884-'85.		1885-'86.		1886-'87.		1887-'88.		1888-'89.		1889-'90.	
	Arri-vals.	De-par-tures.	Arri-vals.	De-par-tures.	Arri-vals.	De-par-tures.	Arri-vals.	De-par-tures.	Arri-vals.	De-par-tures.	Arri-vals.	De-par-tures.
New Orleans	49	55	63	66	34	38	35	37	51	51	38	37
Pittsburg	83	87	103	103	69	70	156	153	237	237	137	134
Other ports	2,005	1,996	2,323	2,314	2,160	2,173	1,380	1,385	2,233	2,234	2,022	2,021
Total	2,137	2,138	2,489	2,483	2,272	2,281	1,580	1,575	2,521	2,522	2,257	2,252

Steamboats landing at Cincinnati.

Year.	No.	Tonnage.	Year.	No.	Tonnage.
1884-'85	205	65,261	1887-'88	151	50,012
1885-'86	196	63,908	1888-'89	152	52,192
1886-'87	168	53,616	1889-'90	144	51,587

Schedule of rates on flour per barrel by rail and river from Cincinnati for 6 years ending August 31, 1890.

Destination.	1885.		1886.		1887.	
	By rail.	By river.	By rail.	By river.	By rail.	By river.
	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
Pittsburg	22 to 28	20	26 to 31	15 to 20	24 to 31	15
Louisville	15	15	15	15	15	15
New Orleans	44 to 56	39 to 48	44	35 to 39	44 to 49	35

Destination.	1888.		1889.		1890.	
	By rail.	By river.	By rail.	By river.	By rail.	By river.
	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
Pittsburg	22 to 24	15	23	15	23 to 24	15
Louisville	15	15	15	15	15	15
New Orleans	40 to 49	35	54	35	49 to 54	35

I am indebted to Maj. G. J. Lydecker, Corps of Engineers, for a statement of the commerce passing the Falls of the Ohio during 1890. It is included in the following table:

2348 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Comparative statement of commerce passing the Falls of the Ohio River by canal and by river.

Year.	Canal.		Open river.		Total.	
	Vessels.	Tons.	Vessels.	Tons.	Vessels.	Tons.
1882.....	3,988	935,628	2,305	668,866	6,293	1,604,494
1883.....	5,231	1,849,115	1,484	483,281	6,715	1,832,396
1884.....	3,485	785,192	1,548	484,124	5,033	1,269,316
1885.....	5,678	1,443,181	822	262,862	6,500	1,706,043
1886.....	4,964	1,240,112	1,796	577,547	6,760	1,817,659
1887.....	4,069	887,807	2,297	1,204,518	6,366	2,072,325
1888.....	6,963	1,915,365	2,252	1,182,305	9,215	3,077,670
1889.....	5,534	1,404,573	1,984	957,829	7,518	2,362,402
1890.....	4,386	998,062	3,828	1,717,158	8,214	2,715,220

In addition to the foregoing statements of the commerce at special localities, efforts have been made, by direct communication with transportation companies, to obtain a statement of the general commerce of the river. The results are embodied in the following table:

Commerce of Ohio River in 1890.

Shippers.	Between what points on the Ohio River.	Distance on Ohio River.	Freight.	Number of passengers.
		Miles.	Tons.	
Coal shipment from Pittsburg*.....	Pittsburg and Cairo.....	965	3,420,357	
Tennessee River Navigation Co.....	do.....	965	37,307	
John Barrett & Son†.....	do.....	965	416,195	
Huntington and St. Louis Towboat Co.†.....	do.....	965	157,802	
A. Montgomery & Co.†.....	do.....	965	13,037	
Steamboat Matt F. Allen.....	Pittsburg and Parkersburg.....	183	10,200	3,600
Steamboat Ben Hur.....	do.....	183	9,418	9,000
Steamboat H. K. Bedford.....	do.....	183	5,500	2,500
Steamboat Louise.....	Pittsburg and Point Pleasant.....	263	26,000	9,500
Pittsburgh and Cincinnati Packet Line.....	Pittsburg and Cincinnati.....	467	132,641	40,899
Steamboat Bob Ballard.....	Marietta and Middleport.....	79	3,080	2,600
Cincinnati and Pomeroy Packet Co.†.....	Pomeroy and Cincinnati.....	219	193,158	54,726
Pomeroy, Cincinnati and Louisville Barge Line.....	Pomeroy and Louisville.....	351	381,500	
Cole and Collins.....	Pomeroy and Cairo.....	718	355,785	
Ella Layman Towboat Co.....	Point Pleasant and Cincinnati.....	203	327,300	
Campbell Creek Coal Co.....	do.....	203	156,060	
Armstrong Bros.....	do.....	203	97,500	
Kanawha River packets.....	do.....	203	16,407	8,618
The Marmet Co.....	Point Pleasant and Louisville.....	336	113,491	
Collier, Budd & Co.....	Point Pleasant and Paducah.....	657	100,000	
Steamboat B. T. Enos.....	Gallipolis and Portsmouth.....	86	26,000	9,000
Steamboat Mink No. 2.....	Ashland and Cincinnati.....	147	20,000	
Henry Spillie & Son.....	Portsmouth and Cincinnati.....	113	10,000	
Buena Vista Freestone Co.....	Buena Vista and Cincinnati.....	96	24,000	
Cincinnati Sand and Gravel Co.....	Ripley and Cincinnati.....	53	15,750	
John Trapp.....	do.....	53	8,937	
Tacoma Packet Co.....	Chilo and Cincinnati.....	36	16,784	28,636
J. M. Blair Brick Co.....	Blairsville and Cincinnati.....	17	50,000	
R. H. Fleming.....	Cincinnati and vicinity.....		16,749	
Steamboat Levi J. Workum.....	Cincinnati and Petersburg.....	25	7,398	950
U. S. Mail Line Co.....	Cincinnati and Louisville.....	132	153,545	100,946
Steamboat New South.....	do.....	132		8,000
Memphis and Cincinnati Packet Co.....	Cincinnati and Cairo.....	499	95,334	14,633
Southern Transportation Line.....	do.....	499	88,617	6,263
Louisville and Evansville Mail Line Co.‡.....	Louisville and Evansville.....	185	98,411	40,470
W. C. Hardwick.....	Louisville and Cairo.....	367	5,000	
Steamboat Frank Stein.....	Cannelton and Evansville.....	67	10,000	15,000
Nashville and Evansville Packet Co.....	Evansville and Paducah.....	137	14,789	950
Evansville and Paducah Packet Co.....	do.....	137	30,980	30,198
Evansville and Tennessee River Packet Co.....	do.....	137	40,000	4,000
Steamboat J. C. Kerr.....	Golconda and Paducah.....	30	20,000	2,600
Steamboat Gus Fowler.....	Paducah and Cairo.....	45	35,000	15,000
St. Louis and Tennessee River Packet Co.....	do.....	45	18,515	1,532
Steamboat New South.....	do.....	45	25,000	7,000
Total.....			6,802,327	416,629

* Coal is stopped at intermediate points.

† General towing.

‡ Regular boat to Portsmouth and one to Maysville. Occasional boat to Pittsburg.

§ One boat to Leavenworth, Ind.

It should be added that there is quite a large amount of short trade commerce, of which statistics could not be procured; it is believed, however, that with additional experience greater success may be obtained in the future.

G G 2.

OPERATING SNAG BOATS ON OHIO RIVER.

The river and harbor act of September 19, 1890, contained the following item:

SEC. 13. That for the purpose of securing the uninterrupted work of operating snag boats on the Ohio River and removing snags, wrecks, and other obstructions in said river, the Secretary of War, upon the application of the Chief of Engineers, is hereby authorized to draw his warrant or requisition from time to time upon the Secretary of the Treasury for such sums as may be necessary to do such work, not to exceed in the aggregate for each year the sum of twenty-five thousand dollars: *Provided, however,* That an itemized statement of said expenses shall accompany the Annual Report of the Chief of Engineers.

In submitting the annual report of the Ohio River snag boat *E. A. Woodruff*, it has been deemed best to continue the practice of reporting the operations of the boat by calendar years, as by this means the report of each season's work is presented by itself, while if the report is made for the fiscal year it must necessarily include parts of two seasons' work, which is less satisfactory. It is evidently necessary, however, in view of the limit to annual expenditures, to report the latter by fiscal years. The present report of operations is for the calendar year 1890, and the report of expenditures covers the period from September 19, 1890, the date of the river and harbor act, to the end of the fiscal year.

After undergoing her annual repairs at Cincinnati, the United States snag boat *E. A. Woodruff* began her season's work on the Ohio River on the 13th of September; she ascended the river as far as Pittsburg, and then worked her way downstream to Cairo, arriving at that place on October 27. Returning, she worked up as far as Long Run, 209 miles below Pittsburg. As the river was rising and too high for successful snagging and wrecking, the boat was again headed downstream, and arrived at Cincinnati November 20.

The *Woodruff* was then ordered into winter quarters at the mouth of the Kentucky River, where she went out of commission on the 24th of November.

During the short working season, which was a very unfavorable one on account of high water, the *Woodruff* removed 204 snags, 3 steam-boat wrecks, 11 coal boats and barges, 2 flats, and 1 wharf-boat hull.

The total distance traveled during the season was 2,641 miles.

Among the most dangerous obstructions removed may be mentioned the hull of the steamer *Wm. Bonner*, from above Burlington Bar, one wheel of same boat from Burlington Bar, and a coal barge from De Witt Bar. The largest snags removed were one at Hartford City, weighing 158 tons, one at Cabell Landing, weighing 433 tons, and one at Three-Mile Island, weighing 161 tons.

2350 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Detailed statement of expenditures for removal of snags and wrecks.

EXPENSES OF U. S. SNAG BOAT E. A. WOODRUFF.

Month.	Pay of crew.	Subsistence.	Fuel.	Miscellaneous supplies.	Tools and implements.	General repairs.	Contingent expenses.	Total.
September	\$796.50	\$227.44	\$116.00	\$17.49	\$7.50	\$61.66		\$1,226.59
October	2,002.42	506.07	359.33	51.17	23.38	37.97	\$0.60	2,981.54
November	1,711.07	400.21	362.53	12.14		40.80	2.50	2,529.25
December	402.80	29.62						432.42
January	400.00	21.42						421.42
February	400.00	16.82						416.83
March	531.25	54.91	36.00				2.50	624.66
April	400.00			5.30			15.00	415.00
May	784.32					3.99	15.50	809.11
June	1,067.95		12.00	46.76		450.33	15.00	2,192.04
Total	9,096.31	1,257.09	885.86	132.86	30.88	594.75	51.10	12,048.85
Outside expenditures.								
May, 1891	1 drag hook						25.50	215.60
	Repairing anchor						10.10	
	Hire of steamboat to remove wrecks						180.00	
Total expenditures for removal of snags and wrecks								12,264.45

G G 3.

OPERATING AND CARE OF DAVIS ISLAND DAM, OHIO RIVER.

This dam has remained under the local charge of Mr. William Martin, C. E., and as usual his services have been extremely valuable.

At the close of the last fiscal year the dam was down and the repairs of the lower lock gate had not been quite completed. These were finished by the 13th of July, and on the 14th the dam was raised. The maneuvers during the year were as follows:

Raised dam July 14.
Lowered dam August 27.
Raised dam September 3.
Lowered dam September 7.

And thereafter the dam continued down until after the subsidence of the spring floods.

Raised dam May 8.
Lowered dam June 7.
Raised dam June 16.
Lowered dam June 19.
Raised dam June 30.

And at the end of the fiscal year the dam was up.

The year just passed resembled the previous one in being remarkably wet, and the services of the dam were seldom needed.

On the 16th of July the bear-trap gates were seriously damaged by a singular accident. A quantity of hay, thrown into the river from a burning stable in Pittsburg, floated down to the dam and was drawn into the filling culverts of the bear trap, cutting off the supply of water and causing the gates to fall, thereby lowering the pool. As soon as possible the valves were cleared, and efforts were made to raise the gates. Owing, as was subsequently ascertained, to the lightness of the track plates on which ran the rollers of the lower leaf, these plates sank into the

wood, and brought the sharp edge of the lower leaf in contact with the under surface of the upper leaf, creating so much friction that the gates refused to rise. After spending several hours in fruitless efforts, the force of workmen left the bear trap and went over to the lock; while they were absent the gates rose with such force as to break the safety chains and the upper beam of the lower gate, forcing this gate past the upper gate, and locking the two together. As the gates remained standing, the level of the pool was not affected, and the maneuvers of the dam went on as usual. Owing to continued high water it was impossible to finish the repair of the gates until May 6; at the close of the fiscal year they were in better order than ever, and with the experience acquired it is believed that no other accident is probable.

The necessity of passing off a large quantity of water through the weirs, on account of a number of small rises that were not high enough to cause the lowering of the whole dam, caused such a dangerous scour of the gravel bottom, although well covered with stone, that additional measures of protection were required. It was found that stone alone would not answer the purpose, and it became necessary to use piling and sunken barges as additional protection. The bottom is now believed to be safe.

As much trouble had been caused by ice and drift making their way into the inner end of the gate recesses, the lock force was employed while the dam was down in making a cut through the inner end of the lower gate recess, with its bottom 2 feet below pool level, so as to run off such material. The operation of this sluice has been very satisfactory, and it is proposed to make a similar one at the upper gate recess.

The high water of February was only 10 inches below the great flood of 1884. It caused some washing near the abutment of the dam behind Davis Island which has been repaired.

The remains of old Pier No. 1, have been leveled down by the use of dynamite, so that the present clear width of opening between the bear trap and the lock is 719 feet.

The new device for handling wickets from below the dam has not proved as useful as was expected on account of the great agitation of the water. It is believed that with the bear trap to draw off drift and ice, and with the increased power on the service boat, it will be possible to handle the dam from above under all probable conditions.

For further details reference is made to the annexed report of Mr. William Martin, the resident engineer.

Estimate for fiscal year ending June 30, 1892.

Salaries.....	\$8, 160
Water-gauge reports.....	300
Telephone.....	240
Natural gas for fuel.....	350
Oil.....	50
Rope, oars, and oakum.....	150
Extra pay of diver.....	60
Post-office box.....	8
New service pump.....	520
Contingencies.....	500
Total.....	10, 338

2352 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Detailed statement of expenses incurred at the Davis Island Dam, Ohio River, during the fiscal year ending June 30, 1891.

Month.	Operating expenses.				Maintenance and repairs.					Grand total.
	Salaries.	Supplies.	Miscellaneous expenses.	Total.	Labor.	Material.	Plant.		Total.	
							Purchase and repairs.	Hire.		
July	\$740.83	\$152.27	\$268.42	\$1,161.52	\$799.83	\$662.03	40.70	\$927.00	\$2,429.56	\$3,591.06
August	678.75	54.14	80.04	812.93	665.42	145.52	40.75	124.50	976.19	1,789.12
September	545.00	29.17	107.30	781.47	218.03	3,029.67	5.45	180.00	3,433.15	4,214.62
October	640.00	29.16	64.80	733.96		10,492.27	2.10	15.50	10,509.87	11,243.83
November	640.00	29.17	21.40	690.57		10.00			10.00	700.57
December	640.00	29.17	28.25	697.42		2.76	7.77		10.53	707.95
January	640.00	33.82	22.00	700.82		1,439.99	1.25		1,441.24	2,142.06
February	640.00	33.82	26.70	700.62		715.30			715.30	1,415.92
March	598.33	33.82	24.53	656.68		17.50			17.50	674.18
April	623.33	48.33	22.00	693.66	247.03	99.04	215.03		561.10	1,254.76
May	668.00	47.62	69.24	784.86	652.70	155.50	294.45	13.00	1,115.65	1,900.51
June	939.00	37.97	49.80	1,026.77		135.00	235.04		390.04	1,416.81
Total	8,093.24	563.56	784.48	9,441.28	2,583.01	16,904.58	862.54	1,260.00	21,610.13	31,051.41

REPORT OF MR. WILLIAM MARTIN, ASSISTANT ENGINEER.

LOCK.

At the close of the last fiscal year the lower lock gate was undergoing repairs, consisting of the renewal of nine axles, with their wheels, and the placing of a new track, as mentioned in the last annual report. The nine axles removed were $3\frac{1}{2}$ inches in diameter, and they were either broken or bent, the wheels having a chilled tread of $2\frac{1}{2}$ inches. The new axles are 6 inches in diameter, having wheels of 6 inches tread.

The old lower gate track rail, which was $\frac{1}{2}$ by 6 inches, was so badly broken and twisted that it was removed, and replaced by a rail $1\frac{1}{2}$ by 11 inches. The upper side of the gate track sill, which forms the gate seat, was faced with an iron plate $\frac{1}{2}$ by 8 inches, and a plate $\frac{1}{2}$ by 6 inches was put on the closed side of the lock gate, thus bringing two flat surfaces of iron into contact when the gate is closed, and reducing the friction to a minimum when opening the gate.

The superiority of this modification is very apparent in the operation of the lower gate, as the hydraulic jack in the river wall, used for starting the gate, is no longer necessary, the gate starting freely without its aid.

All repairs to the lock gate were finished July 11, when the cofferdam, used in making the repairs to the gate, was torn away preparatory to raising the dam, which work was completed, and the dam raised by noon of the 14th.

The operation of the lock gate, since the new wheels and axles were put in, has been very satisfactory.

The screens placed over the valve culverts in the gate recesses, to keep out drift and other débris from the valves, became clogged, preventing the passage of the water into the culverts. The screens were all removed, permitting the débris to pass through the culverts and discharge below the lock. No stoppage of the valves has occurred as a result of removing the screens, except in one valve; the operating machinery of this valve was detached, permitting the use of the others until the stoppage was cleared.

One of the annoyances in the operation of a lock gate which rolls on a straight track into a recess inland has been the accumulation of driftwood in the rear of the gate, preventing its being opened the full width of the lock. The drift is drawn into the recess by the suction caused by the opening of the valves. At the lower gate this has been overcome by cutting a chute through the lower wall of the recess, discharging below the lock all drift which enters the recess.

The chains for both the upper and lower lock-gates being worn out, new ones have been procured.

The brass lining of the hydraulic valve-jack in the river wall worked loose and had to be removed, as the movement of the lining was parallel to the axis of the jack, thus closing the water ports and preventing the operation of the jack. By the removal of the lining the diameter of the cylinder was increased by twice the thickness of the lining, and to centralize the piston I had a cast-iron ring made to fit the cylinder and substituted it for the leather fillers shown by the detail drawing of the

piston in "Details of machinery for operating wickets," dated December 6, 1879. As the jack in the river wall always lacked sufficient power, the increased diameter given it by the removal of the lining makes an increase of power, causing the valves to open more rapidly.

Service pump in river wall of lock.—The piston pump in the river wall, operated by a 25-inch turbine wheel and used for supplying the water tanks which operate the lock filling and discharging valves, broke down on July 25. An examination was made at the time, but no cause of failure could be discovered. During the month of April the pump was taken out of the well in the wall and examined. It was found that the partition wall of the valve chamber had broken out, and the base plate was also broken. Considering the character of the construction of the pump, its repair would be equivalent to a new one.

A new design of the plunger class has been prepared for this pump. In the meantime we are using the steam piston pump to keep up the supply of water until such time as a new pump can be procured.

The question of the property line between the United States and the Pittsburgh, Fort Wayne and Chicago Railway, in regard to which a suit in ejectment has been pending for several years, is still unsettled, but is in a fair way to an amicable adjustment.

MOVABLE DAM.

The Chanoine dam has been in good order during the year. No extra expense has been required. But one steel cross head on a horse of the navigable pass has broken. This will be replaced the next time the dam is raised.

New tripping device.—This device, referred to in the Annual Report of 1889 and 1890, was mounted on a special boat and was designed to lower the dam by working from below instead of from above, as has been customary.

Two trials at lowering the dam were given the device, viz: On August 27 and September 7, and I am free to say our anticipations have not been realized. The agitation of the water below the dam is so great that it is very difficult to control the boat, and the position of the boat over the floor of the dam makes it difficult to clear out the drift before dropping the wicket. Should a wicket from any cause not go down, it is impossible with the apparatus to do anything with it. On the two occasions of lowering the dam in June we worked from above with the maneuvering boat, on which we had mounted a steam winch for use in pulling the boat back. We gave it a trial on June 19, the last time the dam was lowered, and it proves very satisfactory, as it furnishes an abundance of power, in which we were heretofore lacking.

Scour below the dam.—On the occasion of lowering the dam on August 27 and September 7, it was necessary to keep Weir 3 down 3 days before the pass was lowered. This caused a scour of the river bed below to such an extent as to endanger the safety of the foundation of the dam. Immediate steps were taken to prevent serious results by procuring five old coal barges and two flats, loading them with 4,627 tons of riprap stone, and sinking them where the most dangerous scour had taken place. An examination, made recently, shows no movement of the barges or stone, although Weir 3 had been down for 3 days in the early part of June.

Bear trap.—The accident which occurred July 16 to the lower gate of the bear trap by the breaking of the lower stiffening timbers has been repaired. The automatic sliding-stop, for keeping the space between the upper gate and the pier closed to prevent debris getting beneath the gates, has been attached and performs the work for which it was designed satisfactorily.

Considerable scour had taken place below the trap. Injury to the foundation from this cause was guarded against by sinking a coal flat and a barge loaded with riprap stone at a distance of 20 feet below the lower line of the dam. In the interval between these boats and the line of the dam, extending far enough to include the space below the two piers, 1,242 piles were driven, and the interstices between the piling were filled with large riprap stone, a total of 312 tons being used for this purpose.

BACK RIVER DAM.

On the lower slope and apron of this dam a number of planks were torn off by drift during floods; these have been replaced by securing them with ragged drift bolts. The dam is now in good condition throughout.

FENCE ON DAVIS ISLAND.

The fence on Davis Island, dividing the property of the United States from that of Mrs. Klelein, built last year, was destroyed last February by the flood which submerged the island.

2354 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

ARABLE LAND ON DAVIS ISLAND.

With every flood that submerges Davis Island portions of the arable land are carried away. Some plan of restoration should be adopted in the future to recover about 3 acres of the island that has been carried away by floods, and removed by excavations made for the construction of cofferdams.

NATURAL GAS.

The supply of natural gas for light and fuel is still received from the Bellevue and Glenfield Natural Gas Company at the same rate per annum as paid last year, viz, \$350. The supply has been abundant for all purposes.

OPERATION OF DAM.

The dam was maneuvered during the year on the following dates:

Raised.—July 14, September 3, May 8, June 16, June 30.

Lowered.—August 27, September 7, June 7, June 19.

Duration in days of the various stages of water in the Ohio River at the Davis Island Dam since October 7, 1885, to the close of the fiscal year, June 30, 1891.

Month.	1885-'86.			1886-'87.			1887-'88.			1888-'89.			1889-'90.			1890-'91.		
	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.
July.....	.....	.....	.....	7	24	0	21	10	0	3	28	8	0	31	13	14	17	1
August.....	.....	.....	.....	7	24	3	27	4	0	13	18	6	5	26	2	13	18	9
September.....	.....	.....	.....	19	11	0	30	0	0	1	29	6	18	12	0	0	30	21
October.....	12	19	7	28	5	0	30	1	0	1	30	23	6	25	3	0	31	31
November.....	0	30	22	12	18	16	19	11	0	0	30	26	0	30	30	0	30	29
December.....	0	31	27	0	31	22	2	29	0	0	31	18	0	31	31	0	31	17
January.....	0	31	28	0	31	17	1	30	19	0	31	30	0	31	31	0	31	31
February.....	0	28	21	0	28	28	0	29	26	0	28	13	0	28	28	0	28	28
March.....	0	31	17	0	31	18	0	31	29	0	31	29	0	31	31	0	31	31
April.....	0	30	21	0	30	13	0	30	25	0	30	25	0	30	26	0	30	26
May.....	0	31	11	0	31	16	0	31	13	0	31	21	0	31	31	1	30	0
June.....	2	28	5	3	27	7	1	29	2	0	30	30	0	30	21	0	30	21
Year.....	14	259	159	74	291	140	131	235	114	18	347	235	29	336	247	28	337	245

G G 4.

MOVABLE DAM IN OHIO RIVER NEAR MOUTH OF BEAVER RIVER, PENN- SYLVANIA.

The river and harbor act of September 19, 1890, contains the following item:

Improving the Ohio River by the construction of a movable dam at or below the mouth of Beaver River, Pennsylvania, at such locality as the Secretary of War may consider most advantageous, two hundred and fifty thousand dollars.

The first question that arose under this act was that of location. It needed only a glance at the map to show that no acceptable dam could be located at the mouth of the Beaver River, as this tributary enters the Ohio at the apex of a sharp bend, and the latter stream is crossed by a bridge a short distance below. Navigation is already quite difficult at this point, and any additional complication was manifestly inadmissible. As the law did not permit a location above the mouth of Beaver River, it was evidently necessary to seek one below this point.

The first one selected was 1,600 feet below the Beaver Bridge, but the coal interest objected on account of the danger at certain stages of hitting the river wall of the lock. A second site was then chosen just below the Beaver Shoals Dike. This was also objected to, and a third site was selected near Vanport, Pa., 5 miles below the mouth of Beaver River. The last selection proved satisfactory to the coal interest.

The next question to be settled was that of connection with the existing movable dam at Davis Island. It was assumed that at some future time the new movable Dam would form one of a series of which the Davis Island Dam is the first, and hence the location of the new dam practically involved the approximate location of all the dams between it and Davis Island.

After careful study it was decided that the required locations could be made, and that the new dam would be the sixth of the series. A profile showing the heights, lifts, and navigable depths of the first six movable dams on the Ohio River was submitted to the Chief of Engineers, and on the 29th of April the proposed site of the Beaver Dam was formally approved by the Acting Secretary of War.

The next point was the purchase of the necessary land on both banks. An offer of \$1,000 for 6 acres was made to the owner of the land on the right bank, but he declined it. On the left bank the property belonged to Beaver County, Pa., being in charge of the directors of the county infirmary, who had no authority to sell any part of the same.

Under these circumstances the United States District Attorney procured the appointment of a board of appraisers, who met on the 27th of June. On that day the owner of the land on the right bank decided to accept the offer that had been made to him, and the Board appraised the land on the left bank at the same rate per acre. As the amount of this land is 3.46 acres, the total cost of the land required for the Beaver Dam will be \$1,576.67.

The title papers are now in process of execution, and will be completed at an early day.

An estimate of \$250,000 for continuing work on this dam is submitted. It is very desirable that when work of this character is once begun it should be carried through without cessation, as any stoppage during the working season adds greatly to the ultimate cost.

Money statement.

Amount appropriated by act approved September 19, 1890	\$250,000.00
June 30, 1891, amount expended during fiscal year.....	1,381.23
July 1, 1891, balance unexpended	248,618.77
<hr/>	
{ Amount (estimated) required for completion of existing project.....	650,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	250,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

G G 5.

IMPROVEMENT OF MONONGAHELA RIVER, WEST VIRGINIA AND PENNSYLVANIA.

The late appropriations under this heading were applied to the construction of Lock and Dam No. 8, at the mouth of Dunkard Creek. This work was opened to navigation in November, 1889; at that time it was

not quite complete, and the balance on hand has been expended in supplying the omissions.

During the year the dam was backed with gravel, and two lock-keepers' houses were built and occupied. The cavities in the terreplein were filled, and the whole area was paved. The T of the abutment on the left shore was extended farther into the solid bank as a measure of precaution, and the bank below the abutment was graded and paved.

The guiding crib below the land wall was raised and extended into the bank. As the operation of this lock is a charge against the indefinite appropriation for "operating and care of canals and other works of navigation," reference is made to the report under that heading for further particulars.

Money statement.

July 1, 1890, balance unexpended	\$15,917.20
June 30, 1891, amount expended during fiscal year	15,115.54
July 1, 1891, balance unexpended	801.66
July 1, 1891, outstanding liabilities	49.53
July 1, 1891, balance available	752.13

COMMERCIAL STATISTICS.

The following table compiled from the annual reports of the Monongahela Navigation Company shows the commercial movement on the lower part of this river for the past seven years.

Articles.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Brick	1,467	1,325	8,997	5,279	4,504	6,333	7,856
Cattle and horses	108	374	396	501	565	729	648
Classified freight	13,890	13,683	13,086	16,486	17,450	18,334	23,169
Coal and cooke	3,104,890	3,265,078	4,297,768	2,968,690	4,400,996	3,084,175	4,486,323
Fire clay	2,140	3,463	3,295	2,383	2,476	5,982	5,021
Hogs	254	138	83	250	379	266	340
Iron:							
ore	20,840	16,486	17,823	17,683	8,079	2,371	2,335
in pigs	17	11	5	7	10	15	5
Lumber	10,714	9,622	10,231	11,144	13,778	10,095	11,615
Oil	9	1,073		55			
Pipe		595		2,285			2,304
Posts	5	256	437	258	489	700	1,089
Posts pit	35,072	32,166	18,392	30,472	22,432	18,707	29,336
Railroad ties	1,256	135	161	30	555	3,165	232
Sand	37,345	51,771	59,229	89,230	63,085	78,590	105,000
Sheep	170	134	108	233	193	164	60
Staves		9			7	26	140
Steel rails	23,844	22,428	45,795	57,490	10,688	82,177	34,609
Stone	56,116	7,612	4,621	910	3,636	9,580	811
Timber	47,084	46,172	52,068	53,561	84,191	54,096	43,970
Whisky	254	198	164	49	88	134	180
Wood		230	196		184		52
Total	3,355,425	3,472,959	4,533,484	3,287,005	4,634,785	3,822,239	4,755,774
Passengers, number	26,871	24,668	26,885	50,584	44,714	45,811	31,822

The following table shows the commerce that passed through United States Lock No. 8 during 1890:

Month.	Ascending.		Descending.	
	Passen- gers.	Freight.	Passen- gers.	Freight.
	<i>No.</i>	<i>Tons.</i>	<i>No.</i>	<i>Tons.</i>
January	352	165.18	414	2,752.93
February	266	130.92	307	289.98
March	265	288.55	315	4,652.44
April	332	252.00	333	6,627.55
May	691	240.15	560	1,188.60
June	658	259.15	481	3,609.33
July	2,074	379.20	1,616	2,061.91
August	3,230	223.75	3,373	553.27
September	662	353.70	777	1,197.30
October	644	404.75	705	4,980.00
November	378	384.58	447	1,187.80
December	352	277.95	439	332.00
Total	9,904	3,359.88	9,767	29,423.11

The following table shows the commerce that passed through United States Lock No. 9 during 1890:

Month.	Ascending.		Descending.	
	Passen- gers.	Freight.	Passen- gers.	Freight.
	<i>No.</i>	<i>Tons.</i>	<i>No.</i>	<i>Tons.</i>
January	352	165.18	414	154.50
February	266	132.42	307	42.85
March	265	313.55	315	1,010.70
April	332	302.00	333	1,920.83
May	691	407.15	560	843.68
June	658	322.65	481	894.14
July	1,905	901.30	1,590	922.90
August	2,900	924.23	2,831	345.16
September	637	540.90	664	597.10
October	637	383.55	589	1,295.25
November	419	553.91	412	285.20
December	381	447.05	375	299.25
Total	9,493	5,093.89	8,602	8,611.56

Taking the average of the totals given in the last two tables we find that the commerce during 1890 on the 14 miles of the Monongahela River which is controlled by the United States is as follows:

Tons of freight..... 23,244
 Passengers..... 18,883

G G 6.

OPERATING AND CARE OF LOCKS AND DAMS NOS. 8 AND 9, MONONGAHELA RIVER.

The Monongahela River, from Morgantown, W. Va., to its mouth at Pittsburg, is canalized by nine locks and dams, of which the first seven, counting from Pittsburg, are the property of the Monongahela Navigation Company and the eighth and ninth are the property of the United States. The eighth dam is 88.15 miles above Pittsburg, and Morgantown, the head of the slack water, is 102.16 miles from the same. It may therefore be stated that 14 miles of this river is under the direct control of the United States and 88 miles is under a private corporation.

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During the year these locks and dams have been under the direct control of Mr. P. Golay as resident engineer, and for details reference is made to his report, which is hereto annexed.

Estimate for fiscal year ending June 30, 1892.

Salaries	\$4, 800
Office expenses.....	200
Oil and coal	150
Traveling expenses	300
Submarine armor	800
Repairing Dam No. 8.....	9, 500
Repairing Dam No. 9.....	5, 000
Protecting bank below Lock 8	1, 700
Contingencies	1, 800
Total	24, 250

Detailed statement of expenses incurred in operating and care of locks and dams on the Monongahela River during the fiscal year ending June 30, 1891.

Month.	Operating expenses.				Tools and appliances.	Dredg- ing.	Repairs.			Grand total.
	Sal-aries.	Sup-plies.	Miscel- laneous ex- penses.	Total.			Labor.	Mate- rial.	Total.	
1890.										
July	\$161.17	\$0.63	\$29.07	\$493.87	\$7.41	.....	\$164.34	\$7.31	\$171.65	\$672.93
August	420.00	.65	44.83	465.48	8.62	\$1,740.00	.....	533.46	.....	2,747.56
September	400.00	33.65	1.25	434.90	25.29	.....	502.74	154.69	657.46	1,117.62
October	400.00	24.00	3.00	427.00	24.73	.....	398.88	115.62	514.50	966.23
November.....	400.00	18.95	6.00	424.95	2.75	.....	47.23	225.17	272.40	700.10
December.....	400.00	27.05	9.40	436.45	56.40	.....	8.00	229.49	237.49	730.34
1891.										
January	450.00	.....	34.11	484.11	37.50	.....	38.97	35.54	74.51	596.12
February	520.00	2.75	28.25	551.00	3.73	.....	58.76	39.50	98.35	653.06
March	415.00	14.90	8.00	437.90	4.00	1,200.23	.....	.....	.....	1,642.13
April	415.00	.....	.....	415.00	18.06	250.83	.....	.....	.....	683.89
May	453.40	.....	36.26	489.66	.....	.....	40.63	143.93	184.56	674.22
June.....	475.00	.....	2.20	477.20	.....	.....	134.22	70.15	204.37	681.57
Total	5,212.57	122.58	202.37	5,537.52	188.49	3,191.06	1,393.77	1,554.95	2,415.29	11,865.79

REPORT OF MR. PHILIP GOLAY, ASSISTANT ENGINEER.

SIR: I have the honor to submit the following report on operating and care of locks and dams on the Monongahela River, West Virginia and Pennsylvania, for the fiscal year ending June 30, 1891:

LOCK AND DAM NO. 8, MOUTH OF DUNKARD CREEK.

At the beginning of the fiscal year, it was found that the apron of the dam had sustained an injury. A small portion of the sheeting, together with one or two stringers, had risen at the toe, and the damage has been considerably augmented by subsequent rises of the river, so that at present nearly all the sheeting of the dam is lifted. On account of unusually high water during the entire year, repairs of this character could not be made. It is the intention to repair the damage at the earliest possible opportunity.

Changes and improvements in operating machinery.—The stems of the valves for filling and emptying the lock chamber were not constructed originally with a view of closing under pressure, a condition making it both difficult and very tedious to drain and refill the pool whenever this became necessary for making repairs. The stems of the two filling valves have been stiffened, leaving those of the emptying valves yet to be changed. The new condition will also be more advantageous if for any reason, while operating the lock, it should become necessary to change from filling to empty-

ing the lock chamber, or from emptying to filling; also for flushing drift from within and below the lock.

The capstan barrels were removed and new ones of improved pattern were substituted.

The operating machinery was covered with plank instead of the iron grating formerly used. The admission of rain and snow and of sand and mud during freshets was an objection to the open grating.

Bell-crank brakes were applied to the frictions of the chain drums to enable the lock keeper to control the chains, and prevent their running off the drum and fouling.

On account of the excessive thrust, the spider supporting the step in one of the turbines gave way, allowing the turbine wheel and shaft to drop, and so breaking the wheel that another had to be purchased to take its place. Additional support was given to all the turbines by means of thrust bearings on the shafts. The results were increased power and no further breaking.

Upon the adoption of positive in place of friction cone clutches, it was found difficult to release their hold when the chains were taut. To obviate this difficulty, square steel studs were inserted in the tops of the turbine shafts, by means of which the lock keeper can turn the turbine backward sufficiently to slack the chains. The clutches can then be released with ease.

Dredging.—In the month of August a dredge was hired from the Monongahela and Western Company, of Pittsburg, to dredge out the approach below Lock No. 8. Three thousand seven hundred cubic yards of material were removed from the channel, giving ample water for navigation.

Early in the month of January a flood piled loose rock and gravel between the river wall of Lock No. 8 and the old cofferdam, closing the outlet of the lower turbine culvert. The United States dredge *Oswego* removed the old cofferdam, and cut a channel 150 feet wide alongside of the river wall and continued it below the lock, thus opening the outlet of the turbine and drawing in a current which it is hoped will prevent shoaling in the approach to the lock from below.

LOCK AND DAM NO. 9, HOARD ROCKS.

The work of repairing the lock walls, commenced in 1889, was finished and the old masonry was given some minor repairs.

The guide crib at the head of the river wall was repaired and raised.

The crib apron of the dam was somewhat damaged; but, as at Lock No. 8, high water prevented repairs.

Dredging.—In connection with the dredging at Lock 8, reported above, the United States dredge *Oswego* removed a bar below Lock 9, which was the cause of a troublesome eddy. It also removed a small bar above the lock and dug out the space between the guide cribs. The lock chamber was cleaned out by washing away the sediment above and below the miter sills with the steamboat wheel.

Very respectfully, your obedient servant,

PHILIP GOLAY,
Assistant Engineer.

Lieut. Col. W. E. MERRILL,
Corps of Engineers.

G G 7.

PURCHASE OF LOCK AND DAM NO. 7, MONONGAHELA RIVER.

At the close of the last fiscal year the case of the United States *vs.* The Monongahela Navigation Company, in the matter of the condemnation of lock and dam No. 7, was set to be heard on appeal at the November term of the circuit court of the United States for the western district of Pennsylvania.

At that term Judge Acheson fixed the sum of \$209,000 as the value of lock and dam No. 7, which is the same sum, in round numbers, that was set by the viewers. Sundry legal questions connected with the case having been decided in favor of the United States, the Navigation Company took an appeal to the Supreme Court of the United States, where the matter is now pending.

The following money statement shows the sums expended during the fiscal year for costs of condemnation:

Money statement.

July 1, 1890, balance unexpended, appropriation for costs of condemnation of lock and dam No. 7, Monongahela River.....	\$3, 533. 87
June 30, 1891, amount expended during fiscal year	3, 431. 55
July 1, 1891, balance unexpended	102. 32

G G 8.

PURCHASE OF LOCK AND DAM NO. 6, MONONGAHELA RIVER.

The river and harbor act of September 19, 1890, contains the following item:

That whenever the proceedings commenced by the United States against the Monongahela Navigation Company, a corporation organized under the laws of Pennsylvania, to condemn Lock and Dam No. 7, constituting a part of the improvement in water communication in the Monongahela River between Pittsburg, in the State of Pennsylvania, and a point at or near Morgantown, in the State of West Virginia, shall be finally determined, and the United States shall have acquired the title to said Lock and Dam No. 7 and its appurtenances, the Secretary of War be, and he is hereby, authorized and directed to negotiate for and purchase, at a cost not to exceed \$162,000, lock and dam No. 6 and its appurtenances of the Monongahela Navigation Company, also constituting a part of said improvement. And the sum of \$162,000, or so much thereof as may be necessary, is hereby appropriated out of any money in the Treasury not otherwise appropriated for consummating said purchase, the same to be paid on the warrant of the Secretary of War upon full and absolute conveyance to the United States of the said Lock and Dam No. 6 and its appurtenances of the said Monongahela Navigation Company.

In the event of the inability of the Secretary of War to make voluntary purchase of said Lock and Dam No. 6 and its appurtenances for said sum of \$162,000 or a less sum, then the Secretary of War is hereby authorized and directed to institute and carry to completion proceedings for the condemnation of said Lock and Dam No. 6 and its appurtenances, said condemnation proceedings to be as prescribed and regulated by the provisions of the general railroad law of Pennsylvania, approved February 19, 1849, and its supplements, except that the United States shall not be required to give any bond, and except that jurisdiction of said proceedings is hereby given to the circuit court of the United States for the western district of Pennsylvania with right of appeal by either party to the Supreme Court of the United States: *Provided*, That in estimating the sum to be paid by the United States, the franchise of said corporation to collect tolls shall not be considered or estimated; and the sum of \$5,000, or so much thereof as may be necessary, is hereby appropriated, out of any moneys in the Treasury not otherwise appropriated, to pay the necessary costs of said condemnation proceedings; and upon final judgment being entered therein the Secretary of War, if in his opinion the judgment is reasonable, is hereby authorized and directed to draw his warrant on the Treasury for the amount of said judgment and costs, and said amount for the payment thereof is hereby appropriated out of any moneys in the Treasury not otherwise appropriated. And when said Lock and Dam No. 6 and its appurtenances shall have been acquired by the United States, whether by purchase or condemnation, the Secretary of War shall take charge thereof, and the same shall thereafter be subject to the provisions of section 4 of an act entitled "An act making appropriations for the construction, repair, and preservation for certain public works on rivers and harbors, and for other purposes," approved July 5, 1884.

As action under these instructions can not be initiated until the United States shall have acquired the title to Lock and Dam No. 7, it is only necessary to state that the paragraphs which are quoted above are yet in abeyance.

Money statement.

Appropriated by act of September 19, 1890—	
For purchase of Lock and Dam No. 6.....	\$162, 000
For costs of condemnation of Lock and Dam No. 6	5, 000

G G 9.

IMPROVEMENT OF CHEAT RIVER, WEST VIRGINIA.

The river and harbor act of September 19, 1890, contained an appropriation of \$13,000 for the improvement of Cheat River.

The object of this improvement is to make the river navigable by loose logs, so as to bring out the immense supplies of timber to be found in the virgin forests on the Cheat and its tributaries. In its natural condition it was impossible to bring down rafts, and a very large percentage of the loose logs was stranded among the rocks and left there to decay from inability to get them into the water. The rough part of the river commences about 3 miles below the Baltimore and Ohio Railroad crossing, at Rowlesburg, and terminates at Beaver Hole, 16 miles above the mouth, where the river emerges from Laurel Ridge. The total length of difficult river is 30 miles.

Work was begun in November, closed in January, and resumed in April. During this period 5,626 cubic yards of rock were broken up, and the river was put in fair condition for the passage of loose logs as far down as Albrights, 14½ miles below Rowlesburg.

In view of the fact that the appropriation was made for completing the improvement of this river, no estimate is submitted, though it is believed that an additional sum could be advantageously expended in removing more obstructions, and in building crib dikes and dams to keep logs in the channel.

For details reference is made to the annexed report of Mr. P. Golay, the local engineer.

Money statement.

Amount appropriated by act approved September 19, 1890.....	\$13,000.00
June 30, 1891, amount expended during fiscal year.....	5,108.15
July 1, 1891, balance unexpended	7,891.85
July 1, 1891, outstanding liabilities.....	1,408.35
July 1, 1891, balance available.....	6,483.50

REPORT OF MR. PHILIP GOLAY, ASSISTANT ENGINEER.

SIR: I have the honor to submit the following report of work on improving Cheat River, West Virginia, for the fiscal year ending June 30, 1891.

The proposed improvement of Cheat River, West Virginia, consists in blasting and removing rock obstructions that have heretofore very materially interfered with the free passage of drifting logs, thereby making the transportation of timber from the vast forests on the head waters of Cheat River to the markets along the Monongahela and Ohio rivers exceedingly hazardous.

Owing to the late date at which the river and harbor act of 1890 passed, and the time necessary for purchasing and transporting tools and material and preparing quarters and means of subsistence for a party of workmen in a sparsely settled mountainous region, no blasting was done until about the 10th of November. Work was continued till January 15, when [rough winter weather forced a suspension. Operations were resumed on April 1 and vigorously prosecuted to the end of the fiscal year. The force employed consisted of 22 men; 5,626 cubic yards of rock obstruction were blasted, broken up, and removed, or leveled down, as follows:

Four hundred and four cubic yards between Hickory Bear Pen Run and a point three-fourths of a mile above, including Buck Horn Bar.

Six hundred and forty-eight cubic yards on Shanty Run Bar. Here a chute 80 feet wide was made across the bar.

Five hundred and seventeen cubic yards between Shanty Run and Bear Willow Run, destroying several lodging places for logs.

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One thousand one hundred and forty-three cubic yards on Boulder Bar, at the foot of the rapids.

One thousand five hundred and seventy-nine cubic yards on Oil Mill Run Bar. This was the most troublesome place in the Narrows. A chute was made the entire length of the bar, 80 feet wide. At the head of the bar the rocks were blasted and leveled down on the river side, so that logs can be driven around whenever there is not enough water to carry them through the chute. About 270 feet down from the head of the bar the rocks were broken up and leveled down from shore to main channel, so that logs stopping at this point may be rolled in with ease.

Six hundred and eight cubic yards of rock obstruction were blasted within the first mile below Oil Mill Run Bar.

Four hundred and sixty-one cubic yards at the mouth of Pringle Run.

One hundred and ninety-one cubic yards at the foot of the Narrows, and 75 cubic yards on Mason Ripple, 4 miles below.

In the consummation of this work, 4,600 pounds of Hercules powder, 1,650 platinum fuses, 3,300 feet of double tape fuse, and 1,400 quintuple-force caps were used.

Isolated bowlders near the center of the stream, and bowlder bars on the convex shore of the river, not being serious obstructions, no unnecessary labor was expended upon them. Attention was given, for the most part, to bowlder bars on the concave shores.

The necessary work on that portion of the river between Rowlesburg and the mouth of Muddy Creek, a distance of 16 miles, including $4\frac{1}{2}$ miles of one of the most troublesome places in the river, is nearly finished. Logs and timber can be drifted over the bowlder bars in from 6 to 8 feet lower water, and with much less labor and loss than before the work was done. Lumbermen express themselves as being well pleased with the new conditions.

New quarters for the workmen have been prepared at Green Island, about 20 miles below Rowlesburg; and a removal of plant and employes to that place is contemplated in the near future.

Very respectfully, your obedient servant,

PHILIP GOLAY,
Assistant Engineer.

Lieut. Col. W. E. MERRILL,
Corps of Engineers.

COMMERCIAL STATISTICS.

The commerce of the Cheat River is restricted to the floating of timber. The only attainable statistics are those obtained from the records of the mills at the mouth of Cheat River. It is known, however, that a considerable amount of timber does not stop at these mills but passes down the Monongahela.

No account can be obtained of this timber, but it assumed that it averages one-fourth of the total output, and it has been estimated at this rate. The following table goes back to 1872, as it was thought advisable to secure data of the product on the river in past years, in order to have means of determining the effect on the commerce on this river of the expenditure just begun for the removal of obstructions.

Timber product of Cheat River for 19 years ending December 31, 1890.

Date.	Received by mills at mouth of river.	Passed on to points below.	Total.	Date.	Received by mills at mouth of river.	Passed on to points below.	Total.
	Tons.	Tons.	Tons.		Tons.	Tons.	Tons.
1872.....	35.00	11.67	46.67	1882.....	428.33	142.78	571.11
1873.....	385.00	128.33	513.33	1883.....	916.67	305.56	1,222.23
1874.....	440.83	146.95	587.78	1884.....	540.83	180.28	721.11
1875.....	340.83	113.61	454.44	1885.....	5,540.83	1,846.94	7,387.77
1876.....	187.17	63.06	252.22	1886.....	4,527.50	1,509.17	6,036.67
1877.....	173.83	57.95	231.78	1887.....	6,035.83	2,011.94	8,047.77
1878.....	196.67	62.22	248.89	1888.....	3,612.50	1,204.17	4,816.67
1879.....	233.33	77.78	311.11	1889.....	5,625.00	1,875.00	7,500.00
1880.....	425.00	141.67	566.67	1890.....	3,741.17	1,247.06	4,988.23
1881.....	383.33	127.78	511.11				

GG 10.

IMPROVEMENT OF ALLEGHENY RIVER, PENNSYLVANIA.

The continued high water that prevailed during the past season was a serious obstacle to all work of river improvement, and progress in this line was much slower than had been anticipated.

Dam at Cornplanter Islands, 204 miles above Pittsburg.—The object of this dam is to close a chute between the Cornplanter Islands, and retain in the main channel the water thus wasted. It would have been better to close the chute at the head of these islands, and this work was actually begun, but it was stopped by an injunction granted in favor of a disused mill privilege. The dam was not quite finished when the season's operations were closed by high water. The work itself stood the winter without injury, but a cut about 30 feet wide was made at each end of the dam. At the close of the fiscal year these gaps were nearly closed.

Dam at Hickory, 158 miles above Pittsburg.—This structure is at the head of Green Island, and it is intended to close the chute behind this island, concentrating the whole flow in one channel. The work has not yet been begun.

Dam at Pithole, 140 miles above Pittsburg.—The object of this dam is to close the chute that passes to the left of Pithole Island. Materials have been accumulated, and at the close of the year 50 feet of the dam was in place.

Dike at Red Bank, 64 miles above Pittsburg.—The work done here was limited to the repair of three compartments of the lower slope of the dike, out of which stone had been washed. This stone was replaced, and the joints in the paving were grouted with cement. As the scour caused by the dike had brought to view a number of large rocks in the new channel, these rocks, amounting to 236 cubic yards, were removed and placed alongside of the dike as a safeguard against longitudinal scour.

Encroachments in the Allegheny Harbor at Pittsburg.—In a large number of cases injunction suits were brought in the United States circuit court to prevent riparian owners from filling up the harbor. The object of these suits is to prevent matters from being made any worse, pending the establishment of harbor lines by the Secretary of War.

To continue the work of improvement on the Allegheny River an estimate of \$50,000 is herewith submitted.

For further details reference is made to the annexed report of Mr. J. W. Arras, civil engineer.

Money statement.

July 1, 1890, balance unexpended.....	\$1,708.18
Amount appropriated by act approved September 19, 1890.....	20,000.00
	<hr/>
	21,708.18
June 30, 1891, amount expended during fiscal year	3,108.30
	<hr/>
July 1, 1891, balance unexpended.....	18,599.88
July 1, 1891, outstanding liabilities.....	835.90
	<hr/>
July 1, 1891, balance available	17,763.98
	<hr/>
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	50,900.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.....	

REPORT OF MR. J. W. ARRAS, ASSISTANT ENGINEER.

PITTSBURG, PA., July 1, 1891.

COLONEL: I have the honor to submit the following report upon the improvement of the Allegheny River for the fiscal year ending June 30, 1891.

The improvements contemplated in your project for the expenditure of the amount appropriated in the last river and harbor act were the completion of the dam at Cornplanter, the erection of dams at Hickory and Pithole, the removal of the bar at the foot of Pithole ripple, and the removal of rock and other obstructions at various places along the river. It was decided to do this work by hired labor and purchase in open market, that being considered the method producing the best results, especially in the matter of the paving of the dam. The appropriation becoming available too late in the season for extensive operations, work during the fall of 1890 was confined to the construction of the Cornplanter dam, and to making some slight repairs on the Red Bank Dike.

Dam at Cornplanter Islands, 204 miles above Pittsburgh.—The modification of the plan of the improvement at Cornplanter, which was under consideration at the close of the last fiscal year, was carried out, the dam across the left branch of the river at the head of the island being abandoned and one being projected to cross the chute between the two upper islands. The construction of this dam was commenced in August, but the unusually frequent rises of last season interfered so much with the progress of the work that when, on October 16, high water necessitated a permanent suspension of operations for the season the dam still lacked 30 feet of closing the chute. In hastening to shut off the chute before winter should set in, the abutment at the root of the dam was left unfinished, thus exposing both banks to wash in case of freshets or ice gorges. Notwithstanding that the work had to remain in this condition during the winter, the only damage done was to the banks, 30 feet of which washed away at each side of the chute. Operations were resumed on June 15, and at the close of the year the dam was nearly finished. The structure is 18 feet wide, 3 feet high above low water, and about 325 feet long. An abutment will be built at each end of the dam to prevent the water from cutting around.

Dam at Hickory, 150 miles above Pittsburgh.—The left branch or low channel of the river at Hickory is obstructed at the foot by a number of very troublesome bars, which spread the water over the entire river bed. The right branch is comparatively free from obstruction, and is generally run by navigators whenever the water is high enough. To improve this point it is proposed to close the left chute at the head of Green's Island with a low dam. The structure will be a crib work filled with stone and paved on the top; the lower side will have a slope and apron. Its width will be 18 feet, its height above low water 3 feet, and its length 730 feet. The timber for this work is being furnished by Messrs. Wheeler and Dusenbury of East Hickory, Pa., who recently had the misfortune to lose their principal mill by fire. Pending the completion of a new mill, the work of construction of the dam is being delayed.

Dam at Pithole, 140 miles above Pittsburgh.—The shoal at this point is one of the worst on the river. The deepest water is along the left bank, but it is not practicable for navigation. The object of the dam is to stop the waste of water down the left and to confine it to the right or navigable channel. It will close the left chute between the main land and Pithole Island, a distance of 1,200 feet. In cross section it is similar to the Hickory Dam. About 1,000 cubic yards of stone have been quarried for the work, and drift bolts and considerable timber are on the ground. At the close of the year 50 feet of the timber work had been put in place.

Removal of bar at Pithole Ripple.—This bar, composed of coarse gravel and boulders, is located nearly in the middle of the channel, and is a very serious obstruction to navigation. Operations on its removal will be commenced as soon as the water reaches a lower stage.

Dike at Red Bank Ripple, 64 miles above Pittsburgh.—The paving which had washed out during the previous winter, in all about 3 squares, was restored last season, and the open joints of the back slope of the dike filled with cement grout. As was expected, the effect of the dike in cutting a new channel was to scour out quite a number of large boulders. Two hundred and thirty-six cubic yards of these were taken out and deposited along the front wall and at the foot of the dike to protect it.

The work of removing obstructions from the channel of the river has not been commenced, as the water has not reached a stage at which this work can be done most advantageously.

ENCROACHMENTS.

The manner in which the Allegheny River is being encroached upon in the cities of Pittsburgh and Allegheny deserves special note. Primarily the object in dumping the refuse into the rivers has been simply to get rid of it, but recently manufacturers, railroad companies, and others, and even the city of Pittsburgh, have been

engaged systematically in filling up as much of the river as possible, and in appropriating the property thus taken to their own uses. This practice has been carried on so extensively that in some instances the stream has been robbed of one-half its width. A narrow, contracted channel may not be so objectionable for through navigation, but for a local or harbor business such as exists at Pittsburg, where thousands of craft are moored almost all the time, it requires no argument to show its impracticability, and the need of all possible room for harbor and landing facilities. During 3 years little heavy ice has passed out of the upper rivers, but it is certainly only a matter of time until there will be heavy ice, and, with a narrow river stripped of its natural safe harbors, it would seem altogether probable that nearly everything moored along its banks must be swept away. It is not surprising, then, that navigators should view the situation with alarm, and vigorously protest against a continuation of the evil.

The cases of encroachment on the Allegheny that have been investigated and reported and the disposition made of them are as follows:

The Western Pennsylvania Exposition Society, the city of Pittsburg, and D. M. Bigelow, making an embankment between the Sixth Street Bridge and the "Point," Pittsburg. In each case a bill in equity was filed by the United States attorney, and at the hearing the defendants filed stipulations agreeing to place nothing more into the river pending the establishment of the United States harbor lines.

Howe, Brown & Co., Limited, the Pittsburg Junction Railway Company, and the city of Pittsburg, making an embankment at Twenty-first street, Pittsburg. On notice given all parties stopped filling.

The Pittsburg and Western Railway Company, constructing a roundhouse at Millvale. On notice given the company removed the part of the structure outside of the State high-water line.

The Porter and Donthell Company, Limited, and James Hunter, making an embankment on the right side of the river below the Sixth Street Bridge. A preliminary injunction was procured.

Isaac Craig and others, making an embankment on the right side of the river below the Sixth Street Bridge. A bill in equity has been filed by the United States attorney.

Respectfully submitted,
Your obedient servant,

J. W. ARRAS,
Assistant Engineer.

Col. WM. E. MERRILL,
Corps of Engineers.

COMMERCIAL STATISTICS.

The following statement of the commerce of the Allegheny River is necessarily incomplete, but it is believed to be as accurate as can be had. It has been compiled by Mr. J. W. Arras, resident engineer:

Articles.	Quantity.	Articles.	Quantity.
	<i>Tons.</i>		<i>Tons.</i>
Barges.....	2,700	Paving stones.....	10,900
Bark.....	1,000	Piles.....	3,000
Barrels.....	964	Railroad ties.....	7,600
Boat bottoms.....	28,800	Rough lumber.....	148,800
Coal.....	1,140	Sand.....	70,000
Fire clay.....	1,144	Staves.....	410
Gas pipe.....	1,265	Stone.....	9,376
General freight.....	1,684	Timber.....	111,518
Hay.....	600		
Nitroglycerine.....	36	Total.....	400,937

Passengers carried, 2,827.

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In addition to the above the following is an approximate statement of the movement of commerce in the Allegheny Harbor of the city of Pittsburg:

Articles.	Quantity.	Articles.	Quantity.
	<i>Tons.</i>		<i>Tons.</i>
Cars, loaded	181, 676	Sand	111, 100
Cars, empty	34, 448	Railroad ties	14, 150
Coal	152, 000	Vegetables	1, 044
Gas pipe	4, 654		
Gravel	18, 000	Total	535, 072
Manure	20, 000		

G G II.

DAM AT HERR ISLAND, ALLEGHENY RIVER.

During the fiscal year the land required on both banks of the river was purchased. The authorities of Allegheny City, to whom the land on the right bank belonged, sold it for the nominal consideration of \$1, on condition that the dam should be a movable one. A petition to the same effect was likewise received from the authorities of the city of Pittsburg, from the Pittsburg Chamber of Commerce, and from the Engineers' Society of Western Pennsylvania. In all the petitions the reason alleged for desiring that the dam be a movable one was the fear that the height of floods in the Allegheny River would be increased by a fixed dam.

The question of the proposed change was referred to the Secretary of War by the Chief of Engineers, and on September 29 it was ordered that the dam at Herr Island be made a movable one. This change in design necessitated a corresponding change in the estimated cost of the work; the estimate for the present design is \$600,000.

It was supposed that after this action there would be no further cause for delay, but a number of riparian owners on the left or Pittsburg side of the river, to whom no allowance for damages had been made, for the reason that the proposed lock was to be outside of the high-water line, brought suit in the circuit court of the United States for compensation. The case was placed in the hands of the United States attorney for the western district of Pennsylvania, and at the close of the fiscal year it had not been argued.

During the year the lot, purchased by the United States as a site for a lockkeeper's house, was filled to the level of the streets without cost to the Government other than the services of a watchman to see that proper material was used.

The enforced delay was utilized in making drawings of the proposed lock.

An estimate of \$200,000 for continuing the work is herewith submitted.

For further particulars reference is made to the annexed report of Mr. J. W. Arras, civil engineer.

Money statement.

July 1, 1890, balance unexpended	\$68, 954. 69
Amount appropriated by act approved September 19, 1890	35, 000. 00
	<hr/>
	103, 954. 69
June 30, 1891, amount expended during fiscal year	33, 306. 46
	<hr/>
July 1, 1891, balance unexpended	70, 648. 23

{ Amount (estimated) required for completion of existing project.....\$524,500.00
 { Amount that can be profitably expended in fiscal year ending June 30, 1893 200,000.00
 { Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. J. W. ARRAS, ASSISTANT ENGINEER.

PITTSBURG, PA., July 1, 1891.

COLONEL: I have the honor to submit the following report upon the construction of the Herr Island Dam, Allegheny River, for the fiscal year ending June 30, 1891:

At the close of the last fiscal year only some formal matters were necessary to place the Government in possession of the land required for the lock buildings and abutment. The deed for the property on the Pittsburg side was received and the price agreed upon was paid. The ordinance granting to the United States land on the right bank of the river for the abutment of the dam, which had passed the common branch of the councils of Allegheny City, was also passed by the select branch and subsequently approved by the mayor. As soon as it was decided to construct a movable instead of a fixed dam the mayor executed a deed in conformity with the ordinance conveying the property to the Government. This deed has since been approved by the Attorney-General of the United States.

With the necessary land procured it was hoped that matters were in shape to commence the work of construction, but at this point another obstacle was met. On behalf of the various proprietors of land back of and abutting on the proposed lock and guide walls a bill in equity was filed in the circuit court of the United States praying for an injunction restraining the Government from building the lock and dam until compensation be made for whatever possible damage the property may suffer through the erection of the walls, and asking for an order of the court requiring the Government to take the proper steps to acquire the right to construct walls in the river in front of these properties. At the close of the year the case had not been argued.

The only work that could be accomplished, until the title to the land is perfect, was to fill up the lot procured on the left bank for the lockkeeper's house. The surface of the lot when purchased was about 8 feet above the low-water level. The lot, as far out as practicable, until the land wall of the lock is built, was raised to the elevation of Twenty-second street, on which it fronts, about 30 feet above low water. The embankment was made of mill cinder, earth, brickbats, etc., which were delivered gratis, the only expense to the Government being the hire of a watchman to keep out garbage and other light materials. About 8,000 cubic yards of material was placed in the embankment.

Respectfully submitted,

Your obedient servant,

J. W. ARRAS,
Assistant Engineer.Col. WM. E. MERRILL,
Corps of Engineers.

G G 12.

ICE-HARBOR AT MOUTH OF MUSKINGUM RIVER, OHIO.

The ice-harbor is the lower pool of the Muskingum River, which has been created by the slack-water dam at Marietta, and the object of the work under consideration is to build a passway through this dam of such size as will permit Ohio River packets and coal fleets to take refuge from ice in this pool. The passway in question consists of a large lock, which, owing to the local conditions controlling the only available site, had to be built with independent axes of entrance and exit, the angle between these axes being $11^{\circ} 15'$. This involved the necessity of widening the lock chamber at both ends so as to permit boats to change direction while in the lock. The plan of the lock chamber is therefore somewhat like an hourglass, the lock being narrowest in the middle.

The maximum rectangle which can be passed through the lock has a length of 365 feet and a width of 56 feet. The work has been in progress since 1880, but has been kept back by inadequate appropriations and the occasional absence of any appropriation. The river and harbor act of September 19, 1890, contained an appropriation of \$30,000 for this work. As this appropriation was not available until late in the autumn, and the season had been a very wet one, it was judged best to do such work as could be completed without unwatering the lock, but to postpone any extensive work until the spring of 1891. Being in fact a part of the Muskingum River, this work was placed under the local charge of Lieut. C. E. Gillette, Corps of Engineers, whose report is herewith submitted. The foreman of the work is Mr. A. Morris, to whose practical skill and fidelity the Government is very much indebted.

Money statement.

July 1, 1890, balance unexpended	\$287. 78
Amount appropriated by act approved September 19, 1890.....	30, 000. 00
	30, 287. 78
June 30, 1891, amount expended during fiscal year.....	10, 173. 49
July 1, 1891, balance unexpended	20, 114. 29
July 1, 1891, outstanding liabilities	6, 017. 23
	14, 097. 06

REPORT OF LIEUTENANT C. E. GILLETTE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Zanesville, Ohio, July 2, 1891.

SIR: I have to submit the following report of work on the ice harbor at the mouth of the Muskingum River, Ohio, for the fiscal year ending June 30, 1891.

The appropriation for this work became available September 19, 1890, which was too late to justify beginning work with full force before the following spring, as both rivers were quite high. A long stretch of river wall, however, lacked little except coping. One hundred and seventy-five feet of this was completed between October 20 and December 31, the masonry being laid with a crane boat. Work was carried on without interruption from March 30 to the close of the fiscal year, at which date the masonry of the river wall is complete. The land wall is complete for a distance of 286 feet from the upper end. The balance of the wall, 155 feet, is 12 feet above the lower miter sill. The miter sills are complete, and the upper gates are in position. About 1,100 yards of masonry remains to be laid.

Stone from the river wall of old Lock No. 1, Muskingum River, was largely used in the upper courses of the lower half of the river wall. If unexpected delays do not occur, the masonry of this lock will be completed before August 15. The lock, however, can not be made available till a draw is placed in the railroad bridge just below it.

Very respectfully,

CASSIUS E. GILLETTE,
First Lieutenant of Engineers.

Lieut. Col. W. E. MERRILL,
Corps of Engineers, U. S. A.

G G 13.

IMPROVEMENT OF MUSKINGUM RIVER, OHIO.

This report is limited to work carried on under the appropriation of August 11, 1888, for the construction of a lock at Taylorsville and the reconstruction of the lock at Zanesville. It is under the local charge of Lieut. C. E. Gillette, Corps of Engineers.

This work yet to be done is to build and erect lower lock gates at the Taylorsville Lock, to build a guiding crib above the river wall, and to open a channel through the bed rock below the lower end of the lock. This last is the only work that has been pushed during the year, as the other items can be attended to at any time, and it is inadvisable to build lock gates and cribs until they are needed for use. This will not be the case until a draw is placed in the Taylorsville and Duncan Falls Bridge, that crosses the Muskingum River just below the lock. The commissioners of Muskingum County, to whom the bridge belongs, have been ordered to change it, and have been given until September 30, 1891, to do so. Thus far they have made no move towards obeying the order.

The work of opening out the channel below new lock, No. 9, at Taylorsville, was begun July 23 and closed November 1, 1890. High water interfered very materially with the work. Work was resumed May 25 and is still in progress. Seven thousand five hundred yards of earth and 1,600 yards of rock have been excavated. The work was done under protection of a cofferdam, and is now about one-fifth completed.

Money statement.

July 1, 1890, balance unexpended	\$39, 121. 33
June 30, 1891, amount expended during fiscal year.....	3, 820. 09
July 1, 1891, balance unexpended	35, 301. 24
July 1, 1891, outstanding liabilities.....	1, 805. 80
July 1, 1891, balance available	33, 495. 44

G G 14.

OPERATING AND CARE OF LOCKS AND DAMS ON MUSKINGUM RIVER, OHIO.

The season of 1889-'90 was not a fortunate one for river work, but it was nothing compared to the season of 1890-'91, which was extraordinarily unfavorable, the summer and autumn having been phenomenal for high water and floods during the period when low water is anticipated, and when repairs must be made if at all. The fact that the counties of Muskingum and Morgan, through which the Muskingum River flows, lost *eighty* county bridges during the fiscal year, and that railway traffic along the banks of the river was several times stopped by the loss of bridges and trestles, will give some indication of the difficulties that beset the work of rebuilding the locks and dams.

During the year Dam No. 1 at Marietta, Dam No. 6 at Stockport, and Dam No. 8 at Eagleport gave way, and up to the end of the fiscal year it had been impossible to repair the breaks. The bank behind the abutment of Dam No. 4 at Beverly broke through one night without warning, but the dam and abutment remained intact. At the close of

the fiscal year the break had been repaired, as the result of a persevering and masterly contest against heavy odds, the details of which are given in the annexed report of Lieutenant Gillette.

At the close of the year the repairs on Locks 3 and 4 had been completed, and these locks were open to navigation. The repairs on Lock 8 were completed, but the cofferdams had not yet been removed. Locks 6 and 7 were still unfinished, but in each case the difficult work was over, and final success was merely a matter of time.

In reconstructing the Muskingum locks advantage has been taken of the opportunity to make the system uniform by correcting all errors in length and width, by giving uniform guards, so that all locks will be submerged at about the same epoch, by giving equal depths throughout on all miter sills, and by introducing improved valves and apparatus for handling the gates. Wherever the heads of locks were rebuilt, stone miter sills were laid, and the lock was filled through a transverse culvert, discharging by a number of issues under the miter sill, and supplied from vertical wells at each end. The valve used in every case was the low cylindrical valve of Moraillon, described in the *Annales des Ponts et Chaussées* for 1886, which is used on the Central Canal of France and has proved a remarkable success on the Muskingum. As this type of valve requires a vertical discharge, it is not well adapted to use in emptying locks, and for this purpose balanced valves on a vertical shaft have been chosen. These also work very easily and satisfactorily, the only objection being that they can not be made water-tight.

At all locks, recessed ladders of iron have been introduced for convenience in the service of the lock, and as a life-saving precaution. The latest practice is to use four ladders, two at each end.

As much trouble and expense are annually incurred in keeping the canals clear of mud, short sections of needle dam have been built across the heads of the locks at Lowell (No. 3) and Beverly (No. 4) in order to flush out these canals. It is possible with these dams to open both sets of gates, and to send a powerful current through the canal and the lock. As yet there has not been time to test the practicability of keeping the canal clear by this method. The needle dam selected is that in use at the Port à l'Anglais dam since its reconstruction, the needles being provided with the hook devised by M. Lavollée, chief engineer of *Ponts et Chaussées*.

The following is a list of bridges on the Muskingum River which the Secretary of War has ordered to be changed with a view to removing the obstruction to navigation, and a statement of the action thus far taken under these orders:

Fifth Street Bridge in Zanesville.—The work of rebuilding this bridge is advancing rapidly.

Main Street Bridge in Zanesville.—Nothing has been done towards altering this bridge. The time has been extended to December 1, 1892.

Taylorville and Duncan Falls Bridge.—Nothing has yet been done towards altering this bridge.

Beverly and Waterford Bridge.—The alterations to this bridge are well under way.

Upper bridge over Lowell Canal.—Nothing has been done towards altering this bridge. The bridge will probably be abandoned, but the matter is in abeyance, awaiting the results of some modifications recently made in the Lowell Canal.

Railroad Bridge at Marietta.—Nothing has yet been done towards altering this bridge.

For further details reference is made to the annexed report of Lieut. C. E. Gillette, Corps of Engineers, who has been in local charge throughout the year.

The following table shows the condition of the leases on the Muskingum River during the past year and the amounts collected, all of which have been deposited to the credit of the Treasurer of the United States. The amounts are less than usual on account of the rebates allowed for failure of water by the breaking of the dams.

Muskingum River leases for year ending April 30, 1891.

Location.	Lessee.	Dated.	Expires.
Dam 1, Marietta	Phoenix Mill Company	May 1, 1873	May 1, 1903
Dam 2, Devoles	Gates & Payne	May 1, 1889	May 1, 1909
Dam 3, Lowell	Milton King	Nov. 1, 1889	Nov. 1, 1909
Do	F. Wilking & Co	Nov. 1, 1873	Nov. 1, 1903
Do	do	May 1, 1890	May 1, 1910
Do	Rechsteiner Bros	Nov. 1, 1873	Nov. 1, 1903
Do	do	May 1, 1890	May 1, 1910
Do	E. W. Sprague	Dec. 2, 1879	Dec. 15, 1909
Do	George Rice	Sept. 1, 1889	Sept. 1, 1909
Dam 4, Beverly	Robbins Bros	May 1, 1889	May 1, 1909
Do	Stull & Jumper	May 3, 1889	May 3, 1909
Do	H. C. Baldwin	May 11, 1875	May 1, 1905
Do	George S. Worstell	May 1, 1890	May 1, 1910
Do	Mary L. Baldwin	Mar. 28, 1884	May 1, 1914
Do	do	May 1, 1890	May 1, 1910
Do	D. T. Brown	July 13, 1886	July 13, 1916
Do	do	May 1, 1890	May 1, 1910
Do	I. D. Spooner	Nov. 1, 1884	Nov. 1, 1914
Do	Isaac D. Spooner	May 1, 1890	May 1, 1910
Dam 6, Stockport	Joseph Newberry	May 1, 1889	May 1, 1909
Dam 7, McConnelsville	E. M. Stanberry	Sept. 1839	
Dam 9, Duncan Falls	John Miller	Dec. 31, 1836	
Dam 9, Taylorsville	Frazier & Son	do	
Dam 10, Zanesville	Drone & Co	Dec. 7, 1871	Sept. 1, 1901
Do	John T. Drone	May 1, 1890	May 1, 1910
Do	Edward Johnson	Mar. 30, 1872	May 1, 1900
Do	do	May 1, 1890	May 1, 1910
Do	do	May 1, 1889	May 1, 1909
Do	Joseph Shaw	Sept. 6, 1881	Aug. 1, 1911
Do	do	May 1, 1890	May 1, 1910
Do	Gary Bros. & Silvey	May 1, 1862	May 1, 1892
Do	do	Dec. 10, 1873	Nov. 1, 1903
Do	do	Nov. 30, 1887	
Do	do	May 1, 1890	May 1, 1910
Do	Gary & McLaughlin	do	Do.
Do	Beaumont & Blankenbuhler	July 1, 1889	July 1, 1909
Symmes Creek	Sarah V. Plummer	Apr. 2, 1889	Apr. 2, 1894

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Muskingum River leases for year ending April 30, 1891—Continued.

Lessee.	Subject.	Cubic feet of water per minute.	Annual rental.	Rebate allowed.	Rents collected.
Phoenix Mill Company.....	Water-power.....	3,000	\$350.00	\$303.87	\$46.13
Gates & Payne.....	do.....	9,000	108.00		108.00
Milton King*.....	do.....	2,600	100.00		
F. Wilking & Co.†.....	do.....				
Do.....	do.....	7,280	174.72		174.72
Rechsteiner Bros.‡.....	do.....				
Do.....	do.....	4,446	106.70		106.70
E. W. Sprague.....	Land.....		5.00		5.00
George Rice.....	do.....		6.00		6.00
Robbins Bros.....	Water-power.....	1,904	100.00	34.84	65.16
Stall & Jumper.....	do.....	5,293	127.03	44.26	82.78
H. C. Baldwin†.....	do.....				
George S. Worstell.....	do.....	5,000	111.24	39.81	74.43
Mary L. Baldwin†.....	do.....				
Do.....	do.....	5,000	100.00	34.84	65.16
D. T. Brown†.....	do.....				
Do.....	do.....	6,500	118.30	41.23	77.07
I. D. Spornert.....	do.....				
Isaac D. Spornert.....	do.....	4,000	100.00	34.84	65.16
Joseph Newberry.....	do.....	6,396	230.04	19.12	130.72
E. M. Stanberry†.....	do.....	(§)			
John Miller†.....	do.....	(||)			
Frazier & Son†.....	do.....	(||)			
Drone & Co†.....	do.....				
John T. Drone.....	do.....	7,500	453.60		453.60
Edward Johnson†.....	do.....				
Do.....	do.....	6,029	301.74		301.74
Do.....	do.....	7,397	443.82		443.82
Joseph Shaw†.....	do.....				
Do.....	do.....	4,619	207.85		207.85
Gary Bros. & Silvey†.....	do.....				
Do†.....	Land.....				
Do‡.....	do.....				
Do**.....	Water-power.....	4,794	186.97		182.44
Gary & McLaughlin.....	do.....	4,794	186.97		54.53
Beaumont & Blankenbuhler.....	do.....	7,741	278.68		278.68
Sarah V. Plummer††.....	Land.....				
Total.....					2,939.69

* Lessee insolvent. Water shut off.

† Canceled May 1, 1890.

‡ Perpetual, free lease of water-power.

§ Enough to propel 10 run of 4½ mill-stones.

|| Enough to propel 15 run of 4½ mill-stones.

¶ Revocable license; canceled May 1, 1890.

** Lease transferred to Gary & McLaughlin, January 16, 1891.

†† Terms, 5 years in advance.

Estimate for fiscal year ending June 30, 1892.

Lock and Dam No. 1.....	\$11,000
Lock and Dam No. 2.....	12,000
Lock and Dam No. 3.....	4,000
Lock and Dam No. 4.....	4,000
Lock and Dam No. 5.....	7,500
Lock and Dam No. 6.....	20,000
Lock and Dam No. 7.....	16,500
Lock and Dam No. 8.....	38,000
Lock and Dam No. 9.....	2,000
Lock and Dam No. 10.....	2,000
Lock-keepers' salaries.....	7,000
U. S. steamer <i>Vega</i>	4,500
Dredging.....	15,000
Clerks and draftsmen.....	6,200
Rent, fuel, and gas.....	300
Survey.....	200
Contingencies.....	5,000
Total.....	155,200

Detailed statement of expenses incurred for operating and maintaining the locks and dams on the Muskingum River for the fiscal year ending June 30, 1891.

GENERAL ADMINISTRATION.

Month.	Salaries.		Plant.	
	Office force.	Lock-keepers, bridge-tender, and watchman.	First cost.	Repairs.
July.....	\$515.00	\$490.00	\$765.32	\$316.91
August.....	690.00	490.00	964.47	106.64
September.....	583.00	490.00	399.66	104.08
October.....	520.00	490.00	636.56	177.39
November.....	520.00	435.00	372.54	21.31
December.....	607.50	435.00	89.67	125.71
January.....	546.67	584.00	82.82	31.23
February.....	520.00	584.00	65.75	44.07
March.....	520.00	584.00	159.79	52.37
April.....	520.00	584.00	48.21	77.70
May.....	520.00	564.00	196.39	28.76
June.....		504.00	19.25	6.00
Total.....	6,059.17	6,264.00	3,750.43	1,092.17

Month.	Buildings.	Supplies.	Transportation.	Miscellaneous.	Total.
July.....	\$135.31	\$27.21	\$107.88	\$240.92	\$2,598.55
August.....	5.99	65.32	25.15	120.34	2,467.91
September.....	185.73	12.56	23.04	178.41	1,973.47
October.....	10.75	10.96	31.37	108.37	1,985.40
November.....	36.94	22.02	17.96	82.82	1,508.59
December.....	1.89	63.28	12.46	119.58	1,455.09
January.....	14.00	10.53	8.80	55.95	1,284.00
February.....		9.59	5.98	73.95	1,303.34
March.....	13.04	17.88	2.76	108.92	1,458.76
April.....		20.12		77.96	1,327.99
May.....	.60	2.25	1.10	121.12	1,464.12
June.....			2.65	18.32	550.22
Total.....	404.15	261.71	239.15	1,306.66	19,377.44

U. S. DREDGE MALTA.

Month.	Salaries.	Equipment.	Supplies.	Repairs.	Towboat.	Total.
July.....	\$573.45	\$162.40	\$59.84	\$362.63	\$1,220.00	\$2,378.32
August.....	541.80	128.55	138.81	31.64	620.00	1,460.80
September.....	494.65	39.43	35.50	25.48	600.00	1,195.06
October.....	464.30	7.12	55.70	56.45	220.00	803.57
November.....	550.85	9.75	94.25	29.11	609.00	1,283.96
December.....	520.70	.25	36.40	96.99	436.00	1,080.34
January.....	454.40	6.05	8.30	603.68		1,072.43
February.....	453.05	4.43	2.76	38.30		498.54
March.....	285.86	1.10		264.02		530.98
April.....	163.57			3.00		166.57
May.....	503.20	9.50	16.37		520.00	1,049.07
June.....	531.20					531.20
Total.....	5,517.03	368.58	447.93	1,511.80	4,216.00	12,060.84

2374 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Detailed statement of expenses incurred for operating and maintaining the locks and dams on the Muskingum River, etc.—Continued.

U. S. STEAMER VEGA.

Month.	Salaries.	Equip- ment.	Supplies.	Repairs.	Total.
July	\$287.08	\$1.95	\$1.72	\$1.75	\$292.50
August	331.30		2.00	3.07	336.37
September	360.25	2.55			362.80
October	358.80	22.51	3.90	13.37	398.58
November	355.00		.60	2.80	358.40
December	355.05	.60	.60	.80	357.05
January	352.50		6.18		358.68
February	354.30		.35		354.65
March	196.50			1.60	198.10
April	60.00			2.60	62.60
May	60.00				60.00
June	333.00				333.00
Total	3,403.78	27.61	15.35	25.99	3,472.73

LOCK AND DAM No. 1.

Month.	Labor.	Material.	Supplies.	Boat and engine hire.	Total.
July	\$1,801.54	\$615.54	\$28.56	\$14.00	\$2,459.64
August	8,042.79	4,051.19	125.53	51.00	7,270.51
September	553.67	189.10	1.96	140.00	884.73
October	601.17	592.42	13.00	93.50	1,300.09
November	28.05	240.76		82.50	351.31
December	130.77	855.09		52.50	1,038.36
January	106.15	1,906.59			2,012.74
February	332.82	295.73	5.95		634.50
March	283.95	930.89			1,214.84
April		188.09			188.09
May		1,698.09			1,698.09
June	698.89				698.89
Total	7,580.40	11,562.89	175.00	433.50	19,751.59

LOCK AND DAM No. 2.

Month.	Labor.	Material.	Supplies.	Boat and engine hire.	Total.
July					
August					
September	16.05				16.05
October					
November					
December					
January	8.40				8.40
February	35.55				35.55
March	31.20				31.20
April					
May					
June					
Total	91.20				91.20

LOCK AND DAM No. 3.

Month.	Labor.	Material.	Supplies.	Boat and engine hire.	Total.
July	1,406.21	1,278.14	.58		2,684.93
August	385.18	706.54	37.95	24.00	1,153.67
September	147.90	573.81	.18		721.89
October	40.00	3.58			43.58
November	22.35	259.17			281.52
December	449.85	228.07	.85		678.77
January	36.15	1.76			37.91
February	120.40	805.15	.40		925.95
March	12.45				12.45
April	4.20	184.43			188.63
May	267.80	7.40	.75		275.95
June	977.98	108.80			1,086.78
Total	3,870.47	4,154.85	40.71	24.00	8,090.03

Detailed statement of expenses incurred for operating and maintaining the locks and dams on the Muskingum River, etc.—Continued.

LOCK AND DAM No. 4.

Month.	Labor.	Material.	Supplies.	Boat and engine hire.	Total.
July	\$1,731.50	\$36.87	\$43.40	\$379.00	\$2,190.86
August	4,366.36	2,073.14	.80	170.00	6,610.30
September	3,146.76	1,382.90	20.75	195.00	4,745.50
October	4,588.20	1,681.61	1.40	201.00	6,482.21
November	5,385.29	2,234.61	92.94	202.50	7,919.34
December	5,160.50	1,103.80	58.37	256.28	6,578.95
January	5,302.46	1,321.95	92.82	207.00	7,104.23
February	4,104.05	659.57	18.70	118.75	4,901.07
March	2,507.33	497.30	22.75	184.75	3,212.13
April	2,708.68	1,617.91	38.88	.....	4,365.47
May	1,352.74	131.51	.....	.....	1,484.25
June	2,351.68	.....	.....	.....	2,351.68
Total	42,805.55	12,745.26	390.00	2,004.26	57,945.97

LOCK AND DAM NO. 5.

July	13.35	.....	.....	.....	13.35
August	10.20	6.13	.....	.....	16.33
September .....	.....	.....	.....	.....	.....
October	13.50	382.68	.....	.....	396.18
November	8.25	.....	.....	.....	8.25
December	30.30	.....	.....	.....	30.30
January .....	.....	.....	.....	.....	.....
February	83.10	.....	.....	.....	83.10
March	104.25	.....	.....	.....	104.25
April	13.35	.....	.....	.....	13.35
May	12.60	.....	.....	.....	12.60
June .....	.....	.....	.....	.....	.....
Total	288.90	388.81	.....	.....	677.71

LOCK AND DAM NO. 6.

July	3,668.29	4,109.91	35.20	144.00	7,957.40
August	4,576.87	2,758.05	52.63	31.00	7,418.55
September	2,867.37	1,408.11	38.45	30.00	4,343.93
October	2,413.68	2,268.87	.80	31.00	4,713.35
November	671.76	691.53	28.00	13.00	1,404.29
December	380.43	226.14	.80	.....	586.87
January	54.36	.33	.....	5.50	60.19
February .....	.....	38.87	.....	.....	38.87
March .....	.....	.....	.....	.....	.....
April	469.67	18.96	15	.....	488.78
May	4,129.70	2,021.92	105.73	20.83	6,278.18
June	4,008.27	399.04	358.95	.....	4,856.26
Total	23,310.40	13,941.73	619.71	275.33	38,147.17

LOCK AND DAM NO. 7.

July	2,325.45	1,117.54	123.19	171.00	3,737.18
August	2,871.49	1,956.91	.....	22.50	4,850.90
September	2,149.04	1,535.75	.....	36.25	3,721.04
October	1,823.55	1,633.42	1.00	38.75	3,496.72
November	1,503.32	449.09	.50	37.50	1,990.41
December	1,038.03	312.39	4.70	13.75	1,368.87
January	15.10	.30	.....	.....	15.40
February	335.62	421.47	.....	.....	757.09
March	233.46	1.19	.....	.....	234.65
April	216.57	1,021.80	.....	.....	1,238.37
May	699.80	551.47	.....	.....	1,251.27
June	1,977.34	388.91	.....	.....	2,366.25
Total	15,188.77	9,390.24	129.39	319.75	25,028.15

2376 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Detailed statement of expenses incurred for operating and maintaining the locks and dams on the Muskingum River, etc.—Continued.

LOCK AND DAM NO. 8.

Month.	Labor.	Material.	Supplies.	Boat and engine hire.	Total.
July	\$2,619.47	\$2,750.04	\$121.75	\$51.00	\$5,542.26
August	4,028.65	3,700.85	129.92	31.00	7,890.42
September	3,062.85	1,421.48	63.57	30.00	4,607.90
October	3,435.80	3,481.16	55.35	76.67	7,018.98
November	2,460.46	2,125.97	110.05	89.00	4,785.48
December	2,046.16	63.99	117.62	57.00	2,281.77
January	1,236.79	361.00	90.80	.....	1,688.59
February	746.49	478.70	5.00	.....	1,230.19
March	348.12	11.23	.....	.....	359.35
April	20.03	155.72	.....	.....	175.75
May	1,821.94	1,021.70	36.50	.....	2,880.14
June	2,996.66	105.00	.....	.....	3,101.66
Total	24,853.42	15,676.84	730.56	334.67	41,505.49

LOCK AND DAM NO. 9.

July	553.75	18.14	.....	23.00	594.89
August	40.35	.....	.....	.....	40.35
September	123.15	.....	.....	.....	123.15
October	215.88	82.58	.....	.....	248.46
November .....	.....	.....	.....	.....	.....
December	379.60	64.79	.....	.....	444.39
January .....	.....	.....	.....	.....	.....
February	41.82	19.25	.....	.....	61.07
March .....	.....	.....	.....	.....	.....
April .....	.....	.....	.....	.....	.....
May .....	.....	.....	.....	.....	.....
June .....	.....	.....	.....	.....	.....
Total	1,354.55	134.76	.....	23.00	1,512.31

LOCK AND DAM NO. 10.

July	49.02	4.48	.....	.....	53.50
August	147.50	162.18	1.43	.....	311.11
September	79.80	5.66	.....	.....	85.46
October	550.14	837.42	.....	.....	1,387.00
November	650.07	719.73	.....	.....	1,369.80
December	655.74	188.99	.....	78.00	922.73
January	137.60	.....	.....	.....	137.60
February	42.73	66.00	.....	.....	108.73
March	80.40	.....	.....	.....	80.40
April	21.20	.....	.....	.....	21.20
May	43.40	49.10	.....	.....	92.50
June .....	.....	.....	.....	.....	.....
Total	2,407.64	2,033.56	1.43	78.00	4,520.63

Summary.

General administration	\$19,377.44	Lock and Dam No. 6	\$38,147.17
U. S. dredge Malta	12,060.84	Lock and Dam No. 7	25,028.15
U. S. steamer Vega	3,472.73	Lock and Dam No. 8	41,595.49
Lock and Dam No. 1	19,751.59	Lock and Dam No. 9	1,512.31
Lock and Dam No. 2	91.20	Lock and Dam No. 10	4,520.63
Lock and Dam No. 3	8,090.03	Total	232,271.26
Lock and Dam No. 4	57,945.97		
Lock and Dam No. 5	677.71		

REPORT OF LIEUTENANT C. E. GILLETTE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Zanesville, Ohio, July 2, 1891.

SIR: I have to submit the following report on operating and care of the locks and dams on the Muskingum River, Ohio, for the fiscal year ending June 30, 1891:

The latter part of the season of 1890 was exceedingly unfavorable; sudden and heavy storms, resulting in large floods in the river, frequently destroyed cofferdams and other works and greatly impeded progress. During the four months from July 1 to October 31 there were 42 rainy days, the total rainfall being 22.3 inches, the heaviest being 4 inches on September 6. On July 1, 2.45 inches fell in 50 minutes. On the following dates there was more than 4 feet of water on Dam No. 7, all dates being inclusive: July 2 to 7, September 7 to 18, October 14 to 19, October 24 to 31. The flood of September 13, coming in the midst of the low-water season, lacked only a few inches of being higher than any flood since the great one of 1884. During the same four months there were 62 days when the water below the dams was 5 feet or more above pool level. On July 1 the river above Dam No. 7 rose several feet at the rate of a foot in 12 minutes. On September 8, though there was little or no rain in Zanesville, an insignificant brook, 12 miles below, rose during a local storm to a torrent several hundred feet wide, carrying great quantities of heavy drift. During the above four months no less than 80 important bridges, spanning tributaries of the Muskingum, were destroyed in the counties of Muskingum and Morgan alone. Many smaller ones were damaged or destroyed. Under these conditions the work was necessarily slow and costly.

LOCKS AND DAMS.

Lock and Dam No 1, Marietta.—The flood of July 1 tore out the west half of this dam. It, however, consisted of little else than an old brush and stone cofferdam, built 8 years before. Preparations had previously been made to repair this dam, and materials were partly on hand when the accident occurred. The repairs were begun July 10, and a new section 30 feet long was built next the ice-harbor lock, but not sheeted. A crib 210 feet long was sunk along the toe of the old dam to form the toe of the new slope, and a row of piling was driven along the entire toe of the dam to be used in anchoring it down. Floods in both rivers prevented any further work last season. During the winter the balance of the material was accumulated, and in June the work of framing was begun and is now over half completed. The materials being on hand, a reasonably good season will permit the dam being completed this fall. The old lock being unserviceable, it was partly torn down, the stone of the river wall being used in the ice-harbor lock, and to repair the land wall for use as an abutment. The tearing out for the latter work is about completed.

Lock and Dam No. 3, Lowell.—The masonry of the lock was completed, the lock gates and needle dam were placed in position, and the coffers removed. Navigation is now open through the lock. The high water gave no opportunity to repair the dam, and as the repairs were not very urgent none were made.

Lock and Dam No. 4, Beverly.—On July 16, when there was only about 4 inches of water on the dam, the upper pool broke through apparently under the west abutment, and in a few minutes cut a channel around the abutment about 75 feet wide, the whole river going through the break. The 60 feet of dam next the abutment was empty, the stone having, apparently, gone under the abutment; the water at the toe of the dam was at the normal depth. The exact cause of the accident is uncertain. The abutment was on piling, the bottom of the platform being 2.3 feet below the apron of the dam. The material about the vicinity was of a sandy nature and easily washed. The accident was probably due to the fact that the bottom of the abutment was too high with reference to the toe of the dam and that it was not inclosed with sheet piling or other protection. Springs or small leaks, aided by the reaction below the dam, probably took the material from among the piling nearly to the upper end of the abutment, or possibly beyond it, and the hydrostatic pressure of the upper pool then caused a break through the wall of earth thus left. This breaking through may have been aided by erosion from above. During the previous winter an eddy of considerable power developed above the abutment, due apparently to the shape of the bank. This cut away the bank considerably, and at a point about 100 feet upstream from the abutment the cutting was quite deep, 10 or 12 feet below the crest of the dam. It is possible that a similar deepening may have taken place near enough to the abutment to aid in the break. The cutting of the bank was stopped at the time by throwing in rubblestone. The break must have been sudden, as there was no indication the night before of anything being wrong. Soundings for a new crib extension to the abutment were made two days before the break. The depth at the toe of the abutment was 9 feet on the shore side and 18

feet on the river side, referred to the toe of the dam as zero. The back sheeting of the dam was from 16 to 20 feet long and was not disturbed. Work of closing the break was begun at once. Owing to the strong current under the corner of the abutment, and to the fact that the wash extended nearly to the bottom of the piling, it was unsafe to close the break against the abutment, and a brush and stone cofferdam was accordingly thrown across from a point of the shore to the dam at a point about 80 feet from the abutment. This was finished in August. It was raised to the height of about 4 feet above the crest of the dam. Under its protection a crib was built running directly upstream from the abutment. This was to be a foundation for the embankment closing the break. The flood of August 20 severely tried the brush cofferdam and tore out the crib. The cofferdam was not injured. The renewal of the crib was immediately begun, and a line of sheet piling was driven nearly around the abutment. The flood of September 13 again took out part of the crib. The coffer stood till the 15th, when the end of it next the dam was carried away. It stood all right till a large tree going over the dam caught and tore away the work protecting the end of the coffer on the dam. The dam itself was somewhat injured, but did not break. The width of the gap around was more than doubled. The lateness of the season made it necessary to do most of the work of closing the break in the cofferdam at a comparatively high stage. This was a very difficult operation, but by using large boulders and one or two large trees, with an abundance of brush and stone, it was accomplished early in October. The flood of October 15 came before the cofferdam was raised to its full height, but did little damage. After that the coffer was raised to 12 feet above the dam, and there were no dangerous floods till February 17, when the river rose to a height several feet above any flood since 1884. Work had in the mean time been pushed as rapidly as possible, but it was not yet finished. The embankment was nearly to the height of the abutment, but the levee connecting it with the high-water ground was incomplete, and the river was still narrowed by the cofferdam. It was necessary to work a large force day and night to keep the work above the rising river, but it was finally accomplished and no damage done. Since then work has been prosecuted without serious interruption, and at the close of the year the dam is repaired, the embankment is practically completed, and the removal of the cofferdam has been begun.

The lock being in bad shape, advantage was taken of the drawing down of the pool to begin repairs on it. New miter sills, new cylindrical filling valves, and new gates were put in. The walls were thoroughly repaired with concrete, raised to the standard height, and dressed back to the standard width. The lock is now in operation and is in first-class condition.

Lock and Dam No. 6, Stockport.—Work at this point suffered severely from the floods. The brush and stone coffer around the break in the dam was completed in July. Under its protection the frame coffer around the lock was completed just in time to be destroyed by the flood of August 26. The brush coffer was not damaged, however, and the frame one was replaced as rapidly as possible, only to be entirely carried away, together with a part of the brush coffer, by the flood of September 13. These cofferdams were all more than equal to the demands of an ordinary season, but were utterly unequal to the floods that came against them. The lateness of the season, together with the desirability of prolonging the river wall a few yards upstream, so that the dam could be renewed before winter, made it apparently advisable to use hastily constructed coffers rather than lose valuable time building more substantial ones. This applies only to the frame coffer, that of brush and stone being built in the strongest practicable manner. It is probable that no coffer of reasonable cost, on the smooth rock around the lock, would have stood the flood of September 13, which entirely carried away large dimension stones and heavy cribs filled with rubble. The bases of the derricks in the lock chamber, the pumping engine and pump, and 2 hoisting engines were all carried away, but were afterward recovered. In order to try to rebuild the land wall before winter, a cofferdam was built down the middle of the chamber in October, but in the flood of October 13 this was mostly destroyed. The break in the dam being next to the lock, made it difficult to hold a coffer around the lock till the dam was closed, and there was no time to do that. Work was stopped in the middle of November. During the winter advantage was taken of a period of low water to build a substantial crib parallel to the lock wall and outside the site of the cofferdam. Under its protection work was resumed early in the spring and has been carried on without interruption to the present time, when the land wall is completed for a distance of 61 feet from the lower end, its height being 29 feet 1 inch above the lower miter sill; the next 67 feet of wall is 14½ feet above the lower sill. The river wall is completed for a distance of 61 feet from the lower end, and the balance is 23 feet above the lower sill. The lower gates are built. The brush coffer around the break in the dam is completed and work on the dam will be begun shortly. If the balance of the season is reasonably favorable the work can be completed in October. While the pool was lowered last season the abutment was repaired with concrete.

Lock and Dam No. 7, McConnelville.—It was found that the part of the land wall

that appeared good enough to repair was in very bad shape, the face being almost entirely separated from the body of the wall, and it was decided to tear down the whole wall. Work was carried on to the close of the season, whenever the stage of water would permit. During the first part of the present season, the work being well advanced and not liable to damage, and in view of a probable shortage of funds before the end of the fiscal year, this work was not started till it was certain that no time would be lost at Stockport for lack of funds. At present the work is going on rapidly; the land wall is ready for coping for a distance of 121 feet from the lower end, and the balance is ready for the foundation courses. The river wall is completed for a distance of 109 feet from the lower end; the next 50 feet is ready for the coping; the balance is nearly ready for the foundation courses. The lower miter sill is completed.

During the year upper and lower gates for No. 4, upper gates for No. 8, and guard gates for No. 10 were built. Needles for the dam at the head of Lock No. 3 were made.

Lock and Dam No. 8, Eagleport.—The plan was to rebuild the greater part of the dam, raising it about 4 feet. The unfavorable season prevented this, and no work at all on the dam would have been attempted, except that the middle third of the dam was old and rotten, and there was a break in the upper part of it that was liable to very much enlarge if left over winter; so it was determined to rebuild the middle third of the dam, and more if practicable. A cofferdam of brush and stone was begun around it in July, and a part of the dam was torn out in September. The flood of September 13 broke the cofferdam, and injured the dam itself to some extent. The coffer was rebuilt, but not gravelled, when the flood of October 13 took a part of it out, and before it subsided the dam gave way in the middle; about one-fourth of it went away, and the new slope between the break and the lock was so damaged that during the winter its sheeting was lifted off in a body. The material of it was recovered. Work on the dam was resumed early the present season, and about 100 feet of it next to the lock is almost completed. A large part of the material for the rest of it is on hand.

The excavation for a new abutment has been nearly all made, the materials are mostly on hand, and the plant is in position.

Work on the lock was continued throughout the fiscal year except from March 16 to May 4. At the present date the lock is completed and is in first class condition. The land wall is entirely new, and the river wall thoroughly repaired. The new sills are of masonry, the filling valves are cylindrical, and the emptying valves are balanced. The gates are new, and the lock has the standard dimensions. The cofferdams have not yet been removed.

Lock and Dam No. 9, Taylorsville.—The dam needed extensive minor repairs. A crib forming part of the lower apron, 135 feet long, was rebuilt with no little difficulty on account of the frequent floods. It was completed late in the season, and very probably saved the dam from breaking during the winter. The head of the old canal was several times cleaned out.

Lock and Dam No. 10, Zanesville.—New guard gates, which were urgently needed, were put in, and their buttress walls repaired and raised above the high-water mark of 1884. Extra large valves were put in the gates to admit of supplying the mills during floods.

The dam was in a dangerous condition, as a part of the apron was gone and the second step was badly undermined. A short piece of crib, forming the lower apron, was built in December. The dam was not injured to any extent during the winter.

BOATS.

The dredge Malta did good service when the water was favorable. She dug out Cats Creek Bar at the Head of Lowell Canal, in July, 1890, and again in June, 1891. She removed troublesome bars at Dana Island, 4 miles below Beverly; at Baldwin Ripple, 1 mile below Luke Chute, and partly removed the one at Bear Creek, 1 mile below Lowell; dug out Beverly Canal, and was of valuable assistance in tightening the cofferdam around the break at Beverly, and in removing those at Beverly and Lowell locks. She was not successful in digging material containing rubblestone, and could not be held in swift water. The latter defect has probably been remedied by better spuds. She was fitted with an improved lower tumbler.

The Government steamer Vega was engaged in general towing. The towing for the dredge was done by the hired steamboat *Lizzie Cassel*.

Navigation having been practically shut off during the fiscal year, no commercial statistics are submitted.

Very respectfully,

CASSIUS E. GILLETTE,
First Lieut. of Engineers.

Lieut. Col. W. E. MERRILL,
Corps of Engineers, U. S. A.

GG 15.

PRELIMINARY EXAMINATION OF HARBOR OF OWENSBORO, KENTUCKY,
ON THE OHIO RIVER.

[Printed in House Ex. Doc. No. 199, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 19, 1891.

SIR: I have the honor to submit the accompanying copy of report dated January 12, 1891, by Lieut. Col. Wm. E. Merrill, Corps of Engineers, upon the preliminary examination of "harbor of Owensboro, Ky., on the Ohio River," made in compliance with requirements of the river and harbor act approved September 19, 1890.

Lieutenant-Colonel Merrill is of the opinion that the locality is not worthy of improvement, and I concur in this opinion.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF LIEUTENANT-COLONEL WILLIAM E. MERRILL, CORPS OF
ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, January 12, 1891.

GENERAL: I have the honor to submit the following report on the preliminary examination of the harbor of Owensboro, Ky., as required by the river and harbor act of September 19, 1890.

This is the third time that I have been required to report on this harbor. The first report was ordered in the river and harbor act of July 5, 1884, and it is printed in the Report of the Chief of Engineers for 1885, page 1831. In that report I stated that the harbor was not worthy of improvement. The same item appeared in the river and harbor act of August 11, 1888, and I reaffirmed my former statement that the harbor was not worthy of improvement. This second report is printed in the Report of the Chief of Engineers for 1889, page 1903. As nothing has occurred since the date of my last report to affect my views on this subject, I am under the necessity of stating for the third time that the harbor of Owensboro is not worthy of improvement, and that no survey is necessary.

Respectfully submitted.

WM. E. MERRILL,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

G G 16.

PRELIMINARY EXAMINATION OF TIONESTA [CREEK], PENNSYLVANIA,
FROM THE TOWN OF TIONESTA TO THE VILLAGE OF BALLTOWN, WITH
A VIEW TO THE IMPROVEMENT AND THE REMOVAL OF OBSTRUCTIONS.

[Printed in House Ex. Doc. No. 196, Fifty-first Congress, second session.]

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, January 12, 1891.

GENERAL: I have the honor to submit the following report on the preliminary examination, as required by the river and harbor act of September 19, 1890, of the creek called "Tionesta, from the town of Tionesta to the village of Balltown, with a view to the improvement and the removal of obstructions."

Tionesta Creek is an important tributary of the Allegheny River, which it enters at the town of Tionesta, 152 miles above Pittsburg. As the village of Balltown is 24 miles from the mouth of the Creek, this is the measure of the length of the creek on which a report is desired.

The river and harbor act of August 2, 1882, called for a report on this creek, and I made one, which will be found in the report of the Chief of Engineers for 1884, page 1704.

Tionesta Creek is only used for rafting timber and lumber, but its effectiveness for this purpose is much diminished by the presence of numerous large rocks and some abandoned piers of old rafting booms. No other improvement is sought than the removal of obstructions which impair the use of the creek as a cheap channel for transporting timber and lumber. It is estimated that the sum of \$2,000 judiciously expended will bring all needed relief.

In my judgment the interests of the country demand cheap lumber, and reasonable facilities should be furnished for bringing into use the large quantities of fine timber that otherwise will go to waste for inability to reach a market. My experience also teaches me that small sums, expended on rivers that can only be used for rafting, are relatively more productive than large sums expended on great structures for the benefit of navigation.

I have, therefore, to report that Tionesta Creek is "worthy of improvement" to the extent of removing the obstructions that interfere with its use as a rafting stream, and I estimate that this work can be done for \$2,000. No further survey is necessary.

In this connection I would refer to my former report on this stream; also to the annexed report* of Mr. J. W. Arras, assistant engineer in charge of work on the Allegheny River, which contains such commercial statistics as are obtainable.

Respectfully submitted.

WM. E. MERRILL,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

* Not submitted.

G G 17.

[Printed in House Ex. Doc. No. 195, Fifty-first Congress, second session.]

PRELIMINARY EXAMINATION OF THE OHIO RIVER, BETWEEN THE MOUTH OF GREEN RIVER, KENTUCKY, AND THE CITY OF EVANSVILLE, INDIANA, WITH A VIEW TO IMPROVING THE OHIO RIVER BY CONFINING ITS WATERS WITHIN ITS PRESENT CHANNEL AND PREVENTING DANGER TO NAVIGATION FROM ANY CHANGES THEREIN.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, January 10, 1891.

GENERAL: In compliance with the instructions contained in letter from the Office of the Chief of Engineers, dated September 20, 1890, I have the honor to submit the following report on the preliminary examination of the locality indicated in the following extract from the river and harbor act of September 19, 1890:

With a view to improving the Ohio River, between the mouth of Green River, in the State of Kentucky, and the city of Evansville, in the State of Indiana, and confining the waters of the first-named river within its present channel, and preventing danger to navigation from any changes therein, the Secretary of War is hereby authorized and directed to make, or cause to be made under his direction, a complete survey of the Ohio River between the points named, together with full estimates of any expenditures that may be necessary to prevent any injuries or threatened injuries to its permanent use and navigation.

The cause that led to the request for this survey is the apprehension of some of the citizens of Evansville, Ind., that, at some future date, the Ohio River will cut through the narrow peninsula on the Kentucky side of the river opposite Evansville and leave the latter city on a side channel or bayou.

In the river and harbor act of August 5, 1886, there will be found the following item:

For a survey of the Ohio River near the city of Evansville, Ind., with a view to determine what, if anything, will be necessary to prevent a change of the channel of the river in front of that city.

This survey was duly made, the locality was reported as "worthy of improvement," and the report was printed in House Ex. Doc. No. 88, Fiftieth Congress, first session, and reprinted in the Annual Report of the Chief of Engineers for 1888, page 1716.

While the phraseology of the two items which I have quoted is quite different, they refer to the same subject—the prevention of the Ohio River from cutting across the peninsula opposite Evansville. I do not think that I can add anything to the report that I have just indicated, and I would refer to it as furnishing all the information required by the river and harbor act.

I have therefore to report that the locality is "worthy of improvement," but that no additional survey or report is needed.

Respectfully submitted.

WM. E. MERRILL,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

SURVEY OF THE OHIO RIVER, NEAR THE CITY OF EVANSVILLE, INDIANA, TO DETERMINE WHAT, IF ANYTHING, WILL BE NECESSARY TO PREVENT A CHANGE OF THE CHANNEL OF THE RIVER IN FRONT OF THAT CITY.

UNITED STATES ENGINEER OFFICE,
Cincinnati, November 16, 1887.

SIR: The river and harbor act of August 5, 1886, contained the following item:

For a survey of the Ohio River near the city of Evansville, Ind., with a view to determine what, if anything, will be necessary to prevent a change of the channel of the river in front of that city.

The duty of making this survey having been assigned to me, I have the honor to submit the following report:

The city of Evansville is situated at the apex of a very sharp bend of the Ohio River, the peninsula opposite Evansville having a length of $6\frac{1}{2}$ miles and a minimum width of $1\frac{1}{2}$ miles. The total water front of the peninsula is 15 miles, and its whole surface is on an average about 12 feet below flood level, the extreme oscillation of the river at Evansville being 47.8 feet.

For many years flood water passed over this peninsula without attracting much attention or showing much effect on the surface; but during the high floods of recent years the surface has been considerably degraded, and a number of ravines have been excavated on the upper side of the peninsula, which gradually flatten out and become wide and shallow depressions as they reach the central line. As the soil is fertile, though very light, the crops are valuable, and pretty much the whole area has been cleared and cultivated. Whenever a flood comes of sufficient height to go over the ground the whole surface is denuded to the depth of the plowing, and each year the land is flooded at a lower gauge reading. At the base of the peninsula there is a wide swamp known as Mound Slough. Only a very small portion of this ground has been cleared, and observation shows that in the slough the surface is gradually rising by deposits. A similar condition has been noticed in other parts of the peninsula where ravines and gullies have been abandoned and allowed to grow up with weeds and bushes.

On the Mississippi River, where island chutes are very common, it has been noted that the river hardly ever shows a disposition to deepen and enlarge them into a low-water channel, notwithstanding the fact that strong currents run through these chutes at high water and that they materially shorten distances by river. They are usually the relics of old channels which have gradually been left to one side, and, as a rule, they slowly fill up by the accumulation of snags and sediment. As far as my knowledge goes cut-offs on the Mississippi are always formed by the gradual abrasion of opposite sides of a peninsula until the high-water current has a very steep slope over a barrier only a few hundred feet in width. In view of these facts I am led to conclude that the danger of a cut-off through the Evansville peninsula will not be imminent until the distance across has been reduced to something in the neighborhood of a quarter of a mile, the shortest distance at present being about $1\frac{1}{2}$ miles.

Notwithstanding this conclusion it is evidently undesirable to take any risks in a case of such importance, and therefore I would recommend, as a measure of prudence, that steps be taken to stop any further lowering of the surface of the peninsula, leaving the question of bank protection in abeyance until the necessity for action becomes more evident.

The simple and natural method of accomplishing this result would be to build a levee along the axis of the peninsula, extending it to the insubmersible hills at its base. Two lines for such a levee were surveyed, and the estimated costs of the two are \$305,000 and \$317,000, respectively, the length being $6\frac{1}{2}$ miles and the average depth of flood water 12 feet. The top of the levee has been placed at 4 feet above flood level in order to allow for the raising of the flood line that would follow from keeping the entire discharge within the natural banks. In the above estimates is included \$15,000 for the land on which the levee is to be built. Another method, that would probably be effectual, would be to purchase a strip of ground along the line of the proposed levee, plant it thickly with trees and bushes, and let it stand as a living barrier to catch drift and sediment, and reduce the velocity of the overflow. In my judgment such a barrier would gradually restore the height of the area above it by deposits of sediment, and the owners of the farms on the peninsula could well afford to combine to dedicate and maintain such a strip of woodland. A width of 500 feet would suffice, and the area thus withdrawn from cultivation would contain about 350 acres of arable land and 50 acres of swamp, and would be worth at current rates about \$30,000. While this land would probably fill up with trees and bushes without cost, it would yet be advisable to expedite matters by planting. This would cost about \$40 per acre, making a total for 300 acres of \$12,000. To protect the strip from cattle and from timber thieves it ought to be inclosed by a wire fence, but an unbroken fence would not do, as transverse roads across the strip would be needed in order to preserve communication between the two sides of the peninsula. The road from Evansville to Henderson crosses the line of the proposed forest levee near Mount Slough, and at least four other crossings would be required. To fence both sides of these five crossings and to inclose the two ends would call for about a mile of fence, and the $6\frac{1}{2}$ miles of length would call for 13 miles more, making a total of 14 miles of wire fencing. The cheapest variety of such fence, consisting of posts 16 feet apart and four strands of barbed wire, will cost \$350 per mile. The total cost of the fencing will therefore be \$4,900.

It is possible that in times of flood the current along the transverse roads will cut them into ravines, but this effect can be lessened by curving the lines of the roads; and, in case of necessity, the surface can be metaled or paved at small cost. It is believed that this contingency is remote, and need not be included in the present estimate.

The total estimate is therefore as follows:

Purchase of land.....	\$30,000
Planting trees.....	12,000
Wire fencing.....	4,900
Engineering and contingencies.....	2,100
Total.....	49,000

The law requires the engineer in charge of a survey to state whether or not the locality is "worthy of improvement," and "what public necessity or convenience may be subserved thereby." In case the Ohio River should break through the peninsula opposite Evansville, it would probably have no effect on through commerce, but would very injuriously affect the commerce of Evansville, and would therefore injuriously affect almost the whole commerce of this part of the Ohio River, as no boat passes Evansville without stopping, except a few towboats bound for distant markets. It is therefore a public necessity that such an occurrence should be prevented. While I do not think a cut-off is seriously

threatened at this present, I still think that it would be a judicious expenditure to purchase and maintain a barrier of woodland and thicket along the axis of the peninsula.

For further details, reference is made to the annexed report of Mr. J. N. Caldwell, assistant engineer, who was in charge of the survey.

Accompanying this report is a map* of the locality and a sheet* containing longitudinal and cross sections of the proposed levee.

Respectfully, your obedient servant,

WM. E. MERRILL,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. J. N. CALDWELL, ASSISTANT ENGINEER.

CINCINNATI, OHIO, *October 22, 1887.*

SIR: The river and harbor act of August 5, 1886, ordered "a survey of the Ohio River near the city of Evansville, Indiana, with a view to determine what, if anything, will be necessary to prevent a change of the channel in front of that city."

By your order of June 7, 1887, the charge of this survey was assigned to me, and I have the honor to submit the following report of work done:

Opposite Evansville, Ind., is a peninsula, formed by a bend in the river called the "horseshoe" or "Henderson bend." A survey was made of this peninsula. The general outline of this peninsula resembles that of a human foot with the toe directed towards Evansville.

The distance from the apex of the peninsula to the high ground at the base is 35,000 feet, while the width varies from 4,800 feet to 11,600 feet. The surface is low, being entirely covered with water when the Evansville gauge shows a stage of 42 feet.

The surface soil is very light, being composed largely of sand, and is easily eroded by the water. The soil, being quite fertile, is devoted to crop raising, and most of the trees and bushes have been cleared from the land to fit it for this use. As a consequence, one passing over the peninsula encounters numerous sloughs that have been cut across it by the water. Each rise that covers the land cuts the slough deeper and wider, until at last there seems to be danger that the entire river may leave its old channel and cut through the peninsula. The question might naturally be asked, is this danger any greater now than at any time during the past 20 or 30 years? I think that it is, principally for the reason that the present owners of the land seem to look only to the present, and have used extra diligence in clearing off the trees and bushes. This is especially noticeable on the tract said to be owned by Dr. Harding. I was informed by a man who has cultivated this tract for a number of years, that the former owner maintained a strip of timber along the river bank, which the present owner has almost entirely cleared away, and, as a consequence, the tract has been literally cut to pieces by the floods of the last few years, rendering it almost unfit for cultivation.

The tract south of this one, now owned by Mr. Bennett, is also very badly cut up, and it is here that there is the greatest danger of a cut-off being made, as through this tract the sloughs are most numerous and deepest, and the distance across the peninsula is short, being only 7,900 feet.

There is one important feature that I noticed particularly. Wherever the property owners have neglected to cultivate the soil, the vines, bushes, and trees have grown up rapidly, and by arresting the current at time of high water have caused deposits of soil to be made. Several sloughs, that I was informed had at one time been deep and dangerous, have since filled up to a considerable extent because the owners have ceased to cultivate them, and allowed nature to have her way. The left bank of the river is concave, and is cutting badly, so that the neck of the peninsula is being reduced in two ways.

Your orders to me were "to run a line along the axis of the peninsula from the apex to ground that was above the high water of 1884."

High water of 1884 corresponds with a height of 47.8 feet on the Evansville gauge. I first ran a line of levels from the gauge to a point opposite the apex of the peninsula. The line of levels was run up Fulton avenue for a distance of 1,923 feet. Fulton avenue is the highest street in the principal part of Evansville. Our line was

* Not printed.

then carried across the river, and run as nearly as practicable along the axis of the peninsula. Frequent bench-marks were made. For a distance of 25,000 feet the north and south boundary line of property owners corresponds very nearly with the axis, and I should have followed this line exactly, but in order to do so it would have been necessary to do some clearing of bushes and trees, and these are too valuable to be removed. The profile obtained is essentially the same as though the axis had been followed exactly. From a point 20,000 feet from the apex two lines were run to a swamp called "Mound Slough." One of these follows the axis, and for a distance of 4,250 feet is very close to the Henderson and Evansville road; the other is 1,525 feet further east. After reaching the swamp, I deemed it best to make a detour to reach the high ground; otherwise it would have been necessary to do a great deal of clearing, a thing which it was not desirable to do. A line was run around the peninsula so as to determine its outline; the principal sloughs were run out, and the roads and houses were located. As far as practicable, the owners of the different tracts of land were ascertained, and the property lines were approximately located. I submit herewith a plan* and profile.*

The solid contents of a levee 8 feet wide on top with side slopes of 1 on 3, allowing 20 per cent. for shrinkage, if built on the axis of the peninsula, would be 1,450,687 cubic yards, and it would cost, at 20 cents per cubic yard, \$290,137.40. If built on the other line, with the same form and same allowance for shrinkage, the contents would be 1,508,908 cubic yards, and would cost, at 20 cents per cubic yard, \$301,781.60.

In order to build either of these levees it will be necessary to have a strip of land 35,000 feet long and 250 feet wide, so as to give the necessary width of base and to furnish borrow pits.

This tract will contain about 200 acres, which will cost, at \$80 per acre, the price at which I am informed the land can be bought, \$16,000. Land can probably be bought more readily along the axis than along the other line, for, as mentioned in another place, the axis corresponds with the boundary line between property owners for a distance of 25,000 feet from the apex of the peninsula, and a man will naturally, be more willing to sell a strip off of one side of a tract than through it.

The section of the water way, at the time of high water of 1884, was 556,347 square feet. Should a levee be built this would be reduced to 134,168 square feet.

I have been unable to obtain sufficient information in reference to the velocity of the current at the time of high water of 1884 upon which to base an estimate of the probable increase of flood height at Evansville in case a levee should be built as proposed.

I think that a good protection against the danger of a cut-off being made would be for the United States to buy a strip of land along the axis of the peninsula and plant it with trees and bushes. Such a strip, 35,000 feet long and 500 feet wide, containing about 400 acres, would cost, at \$80 per acre, \$32,000. This tract could be thickly planted with young trees and bushes for about \$40 per acre, or \$16,000 for the whole.

Very respectfully, your obedient servant,

J. N. CALDWELL,
Assistant Engineer.

To Col. W. E. MERRILL,
Corps of Engineers.

* Not printed.

APPENDIX H H.

IMPROVEMENT OF FALLS OF THE OHIO RIVER, OF WABASH RIVER, IN INDIANA AND ILLINOIS, AND OF WHITE RIVER, INDIANA; OPERATING AND CARE OF LOUISVILLE AND PORTLAND CANAL.

REPORT OF MAJOR G. J. LYDECKER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|--|---|
| 1. Falls of the Ohio River, at Louisville, Kentucky. | 3. Operating and care of Louisville and Portland Canal, Kentucky. |
| 2. Indiana Chute, Falls of the Ohio River. | 4. Wabash River, Indiana and Illinois. |
| | 5. White River, Indiana. |

EXAMINATION.

6. Wabash River, Indiana, from Terra [Terre] Haute to La Fayette with a view of removing obstructions of snags and bars and reestablishing the navigation of said river between these cities.
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UNITED STATES ENGINEER OFFICE,
Louisville, Ky., July 13, 1891.

GENERAL: I have the honor to transmit herewith reports * * *
for the fiscal year ending June 30, 1891.

Very respectfully, your obedient servant,

G. J. LYDECKER,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

H H 1.

IMPROVEMENT OF FALLS OF THE OHIO RIVER AT LOUISVILLE, KENTUCKY.

The improvement in progress at this place, under the present approved project, contemplated: First, increased facilities for the passage of commerce through the Louisville and Portland Canal by its enlargement at the entrance and also immediately above the locks, thereby forming capacious basins or harbors at these points; and second, the

improvement of the Indiana Chute, with the object of providing a safe channel through the open river over the falls, which shall be available for the largest tows when the river is at or above an 8-foot stage on the canal gauge.

ENLARGEMENT OF THE LOUISVILLE AND PORTLAND CANAL BASIN ABOVE THE LOCKS.

The work in progress here is in pursuance of the project set forth in the Annual Report for 1887, the object being to construct a basin wherein boats and tows may lie while waiting their turns to enter the locks without interfering with navigation through the canal. The work involved was then estimated to include, as its principal features, the excavation of 124,000 cubic yards of earth, 13,000 cubic yards of rock, and the construction of a retaining wall containing about 5,200 cubic yards of masonry. Operations were commenced under contract in January, 1887, and they dragged along under this contract, with several extensions of time, for nearly 2 years (until December, 1888), when the completion of the work by hired labor was authorized. The necessary working plant having been procured, active operations were commenced in the summer of 1889, and have continued until now during such times as the stage of water would permit.

At the close of the fiscal year ending June 30, 1890, there had been excavated 129,833 cubic yards of earth, 14,380 cubic yards of rock, and 1,439.6 cubic yards of masonry wall built, of which 108.2 cubic yards was concrete, in foundations. The total length of wall built, to varying elevations, was 679 feet, leaving a length of 396 feet that had not been started.

At the beginning of the fiscal year operations on this portion of the work were suspended awaiting the action of Congress on the river and harbor bill, and by the time this bill was approved the river had reached such a stage as to prevent operations, and it so continued until June 1, 1891, when work was resumed. In the meantime a contract was executed for the delivery of stone needed for the new wall, whereby an ample supply for this year's operations has been secured; three additional derricks and a traveling crane for handling the stone on the work and laying it were constructed, and everything put in readiness for expeditious work.

The results accomplished during the working season, being the month of June, 1891, only, were 3,784 cubic yards earth excavation, 171 cubic yards rock excavation, and 468.9 cubic yards masonry wall built; the total work done to June 30, 1891, was 133,617 cubic yards earth excavation, 14,581 cubic yards rock excavated, and 1,908 cubic yards of masonry wall, including concrete foundation, built. This nearly completes the work of excavation for the basin and leaves about 3,300 cubic yards of masonry to be built in order to complete the wall. The amount expended on this work to June 30, 1891, was \$76,850.88.

During the ensuing fiscal year every effort will be made to bring the wall to an elevation of 46.33 canal datum, which will require about 2,500 cubic yards of masonry, and which with a favorable stage of river will be readily accomplished.

ENLARGEMENT OF THE UPPER PORTION OF THE LOUISVILLE AND PORTLAND CANAL.

The project for this improvement was inaugurated in 1883 and modified in 1890, in accordance with the recommendations of a Board of Engineers, as published in the Annual Report for that year (pages 2217 to

2220). Its principal features include the enlargement of the canal to a width of 325 feet for a length of about 1,750 feet westward from the entrance, thence, for a distance of 600 feet, in which the enlargement is reduced to a minimum width of 210 feet; and the removal of the old and construction of a new canal wall of masonry on the northerly line of the enlargement. Above or to the east of this limit of the canal proper the enlargement expands into a basin having a general width of about 800 feet, and a length, in a northeasterly direction, of about 3,200 feet; this basin is to be closed on the west and northwest by a masonry wall, with bear-trap openings, extending in a northerly direction 800 feet from the end of the new canal wall, and by a concrete dam from the north end of the bear-trap structure to the present cross dam at the head of the falls, a distance of about 2,800 feet; on a line substantially parallel to, and 1,200 feet from, the Kentucky shore, which limits the basin on the south. On the completion of this work the old crib work and guiding dike, which extends about 3,600 feet upstream from the old canal wall, will be removed and guide cribs erected on the northerly limits of the excavation from the new basin. Suitable retaining walls or slope revetment will also be constructed along the Kentucky shoreline of the canal.

In the execution of this project most of the excavation required for widening the canal, the construction of the greater part of the new canal wall, and the removal of a portion of the old one, had been completed prior to 1890. The work was done by contract until 1889, when, on account of intolerably slow progress by this method, the completion of the project by hired labor was authorized, and operations have been conducted on that system since that time.

During the fiscal year just closed work was confined to rock excavation in the proposed basin, but progress was greatly retarded by high water, which prevailed throughout most of the year. The pumping machinery was put in position and all preparations made for commencing the year's work in June, 1890, but on account of continuing high water it was the middle of July before active operations could be commenced; they were continued until August 25 only, when the river rose, flooded the site of the work, and put an effective veto on further progress during the year.

The pumps were again put in place last month, and preparations have all been made for resuming work as soon as the river falls to the requisite stage.

During the working period of 28 days 8,072 cubic yards of rock, measured in place, were excavated; the excavation in previous years amounted to 119,455 cubic yards, making to June 30, 1891, the total excavation 127,528 cubic yards.

The amount expended for these improvements up to June 30, 1891, was \$389,612.95.

Some repairs were made to the old cross dam during the year, and to the temporary dams erected for keeping the area of excavation free from water during the working period.

Extracts from the reports of Assistant Engineers G. W. Shaw and R. R. Jones, who have had immediate supervision of the foregoing works, are transmitted herewith.

The commercial statistics relating thereto will be found in my report on operating and care of the Louisville and Portland Canal.

2390 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Money statement.

July 1, 1890, balance unexpended	\$161,635.08
Amount appropriated by act approved September 19, 1890	60,000.00
	<hr/> 221,635.08
June 30, 1891, amount expended during fiscal year	28,488.91
	<hr/> 193,146.17
July 1, 1891, balance unexpended	
July 1, 1891, outstanding liabilities	\$12,018.96
July 1, 1891, amount covered by uncompleted contracts	14,721.32
	<hr/> 26,740.27
July 1, 1891, balance available	<hr/> 166,405.90
<hr/>	
{ Amount (estimated) required for completion of existing project	758,191.34
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	300,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

The estimated amount required for completing the existing project, submitted in the foregoing statement, is obtained as follows:

Estimated cost of work at head of Louisville and Portland Canal recommended by Board of Engineers January 28, 1890	\$710,230.40
Amount expended in execution of that project to June 30, 1891	22,039.06
	<hr/> 688,191.34
Present estimated cost of completing this work	70,000.00
Present estimated cost of completing basin above locks	
Present estimated cost for both	<hr/> 758,191.34

Abstract of proposals for furnishing stone for the construction of wall for enlarging canal basin, Louisville and Portland Canal, received in response to the advertisement dated March 12, 1891, and opened April 11, 1891, by Capt. Edward Maguire, Corps of Engineers.

Quantities in cubic yards and price per cubic yard. Delivered at railroad switch, Eighteenth street and the canal.]

No.	Name of bidder.	Class A.		Class B.		Class C.		Class D.	
		Quantity.	Price.	Quantity.	Price.	Quantity.	Price.	Quantity.	Price.
1	George F. Branham...	420	\$9.50	144	\$9.15	685	\$9.50	224	\$9.15
2	Dark Hollow Quarry Co.	420	11.00	144	10.90	685	10.90	224	10.90
3	Patrick H. Sweeney ..	420	10.74	144	9.74	685	11.74	224	11.74
4	Salem Stone and Lime Co.*	420	8.05	144	8.05	685	8.00	224	8.00
5	Salem Stone and Lime Co.†	420	9.12	144	9.12	685	9.07	224	9.07

No.	Name of bidder.	Class E.		Class F.		Total cost.	Remarks.
		Quantity.	Price.	Quantity.	Price.		
1	George F. Branham	48	\$9.15	300	\$8.75	\$16,328.90	No sample submitted.
2	Dark Hollow Quarry Co.	48	10.35	300	8.50	19,144.50	
3	Patrick H. Sweeney ...	48	8.74	300	7.74	19,326.54	Recommended for acceptance.
4	Salem Stone and Lime Co.*	48	8.00	300	7.40	14,416.20	
5	Salem Stone and Lime Co.†	48	9.07	300	7.66	16,121.67	

* Sample of uneven color.

† Sample of even color.

EXTRACT FROM REPORT OF MR. GRANVILLE W. SHAW, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., June 30, 1891.

MAJOR: I have the honor to submit the following report of operations on improving Falls of the Ohio River at Louisville, Ky.—enlarging the head of the Louisville and Portland Canal—for the fiscal year ending June 30, 1891:

In 1885 the work of excavation was divided into three sections and let by contract; sections 1 and 2, consisting of earth and rock excavation and removal of old river wall, being below Tenth street, and section 3, rock excavation, being in the enlargement above.

Section 1 was completed in November, 1886. After several extensions the contracts for sections 2 and 3 expired December 31, 1888. The officer in charge was then authorized to purchase a plant and finish the contract work by hired labor.

The Salem Stone and Lime Company, under a contract executed January 15, 1887, for the construction of a part of the new canal wall, completed its work on the 24th of August, 1889.

Under authority to purchase a plant and finish the contract work by hired labor suitable tools and appliances were provided, but the season of 1889 proved to be a very short one, only 39 days being available for rock excavation.

During this short season 12,998 cubic yards of solid rock, measured in place, were excavated and removed.

On June 11, 1890, preparations were begun for the season's work. Pumping machinery was placed on the guiding dike, and tools and appliances put in order. Pumping was begun July 14, drilling July 28, blasting July 30, and work suspended by reason of high water August 25, 1890. The season was about 28 days' work in excavation, during which time 8,072 cubic yards of solid rock, measured in place, were blasted and removed.

The braces on the raised portion of the cross dam were found to be very much injured, and were replaced by heavier ones. The concrete dam west of the cross dam was repaired and raised about 1 foot, to direct the leakage into the river north of the improvement. A temporary cofferdam, to prevent leakage, was placed along the north side of the guiding dike, between the cross dam and Thenard shutters. Both of these dams were damaged by the breaking of a log raft, a part of which went over the cross dam within the line of improvement, on September 17, 1890. A new boiler, engine, and centrifugal pump were purchased, and will be used to pump out the water in the excavated area during the coming season.

The total rock excavation on sections 1, 2, and 3, to date, amounts to 127,528 cubic yards, measured in place, of which 8,072 cubic yards were excavated and removed during the fiscal year ending June 30, 1891.

On May 26, 1891, preparations were begun for continuing work. Timber for a platform upon which to place the new pump, engine, and boiler, was brought up from the locks, and the crib and platform finished, when further work was interrupted by high water. On June 20 work was resumed, and the pumping machinery is now in position to be utilized when the river shall have fallen to a 6-foot stage. It is proposed to continue rock excavation on sections 2 and 3.

Very respectfully, your obedient servant,

GRANVILLE W. SHAW,
Assistant Engineer.

Maj. G. J. LYDECKER,
Corps of Engineers, U. S. A.

REPORT OF MR. R. R. JONES, ASSISTANT ENGINEER.

LOUISVILLE, KY., June 30, 1891.

MAJOR: I have the honor to submit the following report of operations for improving Falls of Ohio River at Louisville, Ky., enlarging Canal Basin at head of lock, for the fiscal year ending June 30, 1891:

IMPROVING FALLS OHIO RIVER, ENLARGEMENT OF BASIN.

During the season of 1890, no work was done beyond protecting the derricks, machinery, and exterior bank of the excavation, as the new appropriation for prosecution of the work was not available until the latter part of September, and the balance of the old appropriation was too small to justify even a beginning.

2392 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Early in the season of 1891 preparations were made for the work; 3 additional derricks and a traveling crane were constructed for the purpose of handling and laying stone for new wall.

A contract was made with the Salem Stone and Lime Company for the delivery of about 1,851 yards of Oolitic limestone to be used in the construction of new canal wall, and this amount was subsequently increased to 2,278 cubic yards.

EXCAVATION.

Work was begun June 1, repairing tracks leading to the hoisting incline, and the first car of material was taken from the pit June 3.

The pit was cleaned out, a deposit of river mud about 6 inches thick having covered the entire surface, and the earth which had caved from the banks was removed from the wall so that building could be resumed.

The excavation of earth and rock, principally from the pier separating the dry dock from the canal, was carried on from the dry dock side, as the cofferdam necessary for the completion of the work had been delayed by high water.

All the materials for this dam are on hand, and a start on its construction will be made July 1, unless another rise in the river occurs.

The following table shows the material excavated up to the close of the fiscal year ending June 30, 1891:

	Earth.	Rock.
	Cubic yds.	Cubic yds.
Previous to the close of fiscal year ending June 30, 1890	129,833	14,390
During fiscal year ending June 30, 1891	3,784	171
Total	133,617	14,561

Total material excavated, both earth and rock, 148,168 cubic yards.

NEW CANAL WALL.

Work on the new wall, which was started during the season of 1889 and carried up to varying elevations before the advent of high water, was resumed June 10, 1891.

All the wall thus far started was leveled up to elevation 40.76 by June 27, the material used being old stone taken from the wall at head of canal, which has eventually to be removed, in accordance with the existing project for widening the canal.

The new wall and the manner of its construction is detailed in Report of Chief of Engineers, U. S. Army, 1890, pp. 2214-2215.

On June 27 the laying of new face stone purchased from Salem Stone and Lime Company was commenced.

Both old and new stone will be used for backing this new face stone.

A large amount of concrete is used in the construction of new canal wall and a No. 1 Gates rock crusher has been purchased and set up for the purpose of preparing stone for this purpose. An old engine has been utilized for the power required to run the crusher.

One of the two hoisting engines which were used during season of 1889, being no longer required to run the second incline, has been used to operate the principal derrick used in wall laying and the progress of the work has been greatly expedited thereby.

The following table gives the amount of stone wall laid up to the close of the fiscal year ending June 30, 1891:

	Concrete foundation.	Masonry.
	Cu. yds.	Cu. yds.
Previous to the close of the fiscal year ending June 30, 1890	108.2	1,531.4
During fiscal year ending June 30, 1891		468.9
Total	108.2	1,800.3

Total number cubic yards of concrete foundation and masonry laid to close of fiscal year, June 30, 1891, 1,908.5.

The project for the season of 1891 contemplates the completion of the new wall to elevation 46.33 feet—11.33 feet on upper gauge of canal, from which level it can be

completed with derricks set upon the bank and without the expense of keeping the pit drained.

This construction includes the double-faced wall between dry dock and canal and connections to dry dock pier.

Very respectfully, your obedient servant,

R. R. JONES,
Assistant Engineer.

Maj. G. J. LYDECKER,
Corps of Engineers, U. S. A.

H H 2.

IMPROVEMENT OF INDIANA CHUTE, FALLS OF THE OHIO RIVER.

The object of this improvement is a most important one, and if successfully accomplished will prove of the greatest benefit to the heavy commerce of the river. It is to make this chute safely navigable for the largest tows which characterize this commerce, when the river shows a stage of 8 feet or more, by the upper canal gauge, thereby avoiding the great loss of time involved in the passage of these tows through the canal and locks. To this end the project is that submitted by Major Stickuey, recommended by the Board of Engineers in its report dated January 28, 1890, and approved by the Chief of Engineers January 31, 1890. It involves rock excavation in the proposed channel to the extent of some 60,000 cubic yards, the construction of lateral stone dikes aggregating in length about 3,700 feet, and of a concrete wall about 850 feet long. It is ultimately proposed to construct an additional dike, modify the present cross dam, and connect with the new basin wall at the head of the canal; but the determination of the details for this portion of the proposed improvement is deferred until the precise effects of works in immediate contemplation can be observed.

The work necessary to carrying out the above project can, with the machinery now available, only be done during very low stages of river, and as no such stage was reached during the past fiscal year there is no work to be reported for that period, nor has anything been done on the work since 1887. It seems evident that a plant, suited to carrying on the work when the river is at some higher stage, must be procured before any progress can be realized, and I propose to take the necessary steps for doing so as soon as possible. With such a plant an appropriation of \$75,000, as herein recommended, could be most profitably expended during the fiscal year ending June 30, 1893, and an improvement of the greatest value to commerce thereby secured; for this reason the appropriation of that amount is strongly urged.

Money statement.

July 1, 1890, balance unexpended.....	\$23,885.20
Amount appropriated by act approved September 19, 1890.....	25,000.00
July 1, 1891, balance unexpended	48,885.20
July 1, 1891, outstanding liabilities	10.50
July 1, 1891, balance available.....	48,874.70
{ Amount (estimated) required for completion of existing project.....	113,610.97
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	75,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

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COMMERCIAL STATISTICS.

Statement of vessels passed over the Falls of the Ohio River during the fiscal year ending June 30, 1891.

1890-'91.	Ascending.		Descending.		Total.	
	No.	Tons.	No.	Tons.	No.	Tons.
Passenger boats	132	71,474	402	181,655	534	253,129
Tow boats	206	40,657	307	58,994	513	99,651
Square barges	425	230,518	1,153	684,208	1,578	914,726
Model barges	14	11,200	27	21,500	41	32,700
Total	777	353,849	1,889	946,357	2,666	1,300,204

Days navigable—	
Ascending	116
Descending	283

Statement of commerce passed over the Falls of the Ohio River during the fiscal year ending June 30, 1891.

Articles.	Tons.	Articles.	Tons.	Articles.	Tons.
Coal	677,342	Iron	9,137	Cord wood	435
Salt	1,706	Steel rails	1,692	Peanuts	575
Oil	1,453	Produce	452	Cross-ties	900
Whisky	630	Flour	328	Fire brick	1,425
Tobacco	2,128	Sugar and molasses	3,237	Clinkers	350
Cotton	3,845	Hay and straw	2,747	Sewer pipe	110
Lumber	7,119	Staves and shingles	8,844	Miscellaneous	10,899
Corn	814	Cement	3,372	Stock	3,372
Wheat	185	Vinegar	5		
Iron ore	336	Malt	171		

Comparative statement of commerce passed over the Falls of the Ohio.

Fiscal year.	Open river.			
	Descending vessels.		Ascending vessels.	
	No.	Tons.	No.	Tons.
1882-'83	1,294	398,240	179	61,802
1883-'84	1,384	432,575	301	98,767
1884-'85	708	231,095	95	24,320
1885-'86	1,296	408,619	373	102,536
1886-'87	1,793	991,974	667	290,507
1887-'88	1,514	853,237	361	137,230
1888-'89	893	353,081	102	37,859
1889-'90	2,867	1,358,174	1,191	449,357
1890-'91	1,889	946,357	777	353,849

H H 3.

OPERATING AND CARE OF LOUISVILLE AND PORTLAND CANAL, KENTUCKY.

The work of operating the canal comprises that necessary for the regulation of traffic and commerce passing through it, and is performed under the immediate directions of a master lock manager by a force comprising 1 deputy lock manager, 1 lock master, 1 assistant lock master, 4 engineers, 4 firemen, 4 lock hands, 1 bridge tender, 1 night watchman, and 1 laborer.

During the past fiscal year the locks were available for the passage of commerce for 286 days, and closed 79 days by reason of high water.

The care of the canal is under the immediate supervision of an assistant engineer who is charged with the work of repairs on the canal, locks, and dry dock, dredging the canal and its approaches, and the care of bridges belonging to the United States connected with the work. Operations during the past fiscal year have included the partial construction of a set of new middle gates, the construction of two new dump scows with a capacity of 100 cubic yards each, the repair of two old ones and their enlargement to an increased capacity of about 25 per cent.; trimming rough projections on the canal walls, which have been the cause of considerable damage to passing boats; dredging, and minor repairs to machinery, boats, bridges, and buildings.

NEW MIDDLE GATES.

These are designed to replace the old ones in the new locks and will be 47.75 feet long and 32.875 feet high; or 2 feet higher than the old ones. When they are placed in position it is proposed to raise the timber coping, which was put on the lock walls in February, 1890, to the level of the top of the new lock gates, the practical effect of which will be to raise the walls of the upper lock to a reference of 48.45 (instead of 46.45, as originally built), thereby providing for the use of the locks up to that stage and so materially increasing the number of days for the passage of commerce through them. It is expected that this will be accomplished during the present working season.

TRIMMING CANAL WALL.

This work can only be done when the water in the canal is low, and for that reason but comparatively little was accomplished during the past year; the work will be continued whenever practicable until all prominent projections have been removed; an additional estimate of \$1,500 for this purpose is submitted.

ROCK EXCAVATION OF CHANNEL.

This work is to give an adequate low-water channel in the approach to the lower lock, but the high stage of water that prevailed throughout the year prevented anything being done.

DREDGING.

The dredges worked as usual during the year in removing mud and sand from the canal and its approaches. Much trouble was experienced in keeping the lower approach clear of sand, which was carried by the current from a bar that had formed a short distance above, in such quantities as to make a deposit in a single night of from 4 to 6 feet in depth.

The dilapidated condition of the low dam, extending from the head of Sand Island to the Indiana shore, had, without doubt, much to do with the formation of this bar, and it is therefore proposed to repair it at the first favorable opportunity. The total amount excavated by the two dredges during the year was 100,585 cubic yards, the aggregate number of working days for the two being 351.

DRY DOCK.

The dry dock was used for the repair of 10 steamboats and 10 barges belonging to private parties during a period of 57 days 18 hours, the docking fees derived therefrom being \$677.49. For repairs of boats belonging to the work the dock was in use 20 days,

BRIDGES.

The bridge over the canal at Eighteenth street was newly floored with Georgia Pine in May, 1891, and lumber has been purchased for reflooring the bridge at the new locks.

Both of these bridges are deemed unsafe structures, being truss bridges, nearly all the members in which are of cast iron of small sectional area; they are likely to give way at any time under the passage of heavy loads, and should be replaced by suitable wrought iron structures capable of safely passing any load that is likely to reach them. That at the new locks is in the poorer condition and the more subject to dangerous loads, and an estimate of \$10,000 for replacing it is submitted.

REPAIRS AND MISCELLANEOUS WORK.

Ordinary repairs to dredges, boats, buildings, and machinery were made as required. The towboat was docked and calked, nosings newly ironed, new mud and steam drums put in place, and outside work painted. The framing shed, engine houses and shelter sheds at the locks were painted. A new fence was substituted for the dilapidated old picket fence on the crest of the southerly canal bank, from Fourteenth street to the bridge at the locks.

The slope revetment at lower lock was rebuilt in part, and the remainder will have to be rebuilt at an early day; the river bank below the lock should also be revetted.

The estimated cost of operating and care of the canal during the year ending June 30, 1892, is as follows:

Regular force.....	\$36,000
Extra labor.....	5,000
General repairs.....	5,000
Miscellaneous, fuel, oil, etc.....	6,500
New guard gates, new locks.....	8,000
New guard gates, old locks.....	2,500
Completing new middle gates, new lock.....	4,500
Rebuilding 2 mud scows.....	2,500
New bridge at new locks.....	10,000
Slope revetment, at and below new locks.....	2,500
Rock excavations, channel below locks.....	15,000
Trimming canal walls and rock below.....	1,500
Extending city water supply to locks.....	3,000
New winding engine at locks.....	1,000
Contingencies.....	5,000

Total.....	108,000
The unexpended balance from allotment of last year, exclusive of liabilities now outstanding, is.....	\$29,230.62
The additional allotment required for the year ending June 30, 1892.....	78,769.38

The usual statements of expenditures and commerce on the canal, are given below, and the report of R. R. Jones, assistant engineer, showing in more detail the operations of the year, is transmitted herewith.

Financial statement for operating and care of the Louisville and Portland Canal for the fiscal year ending June 30, 1891.

Receipts:	
Dockage.....	\$677. 49
Rent of land	285. 00
Total	<u>962. 49</u>
Expenditures:	
Office and general administration	6, 041. 58
Canal and locks	27, 640. 83
Dredging	21, 741. 78
Total	<u>55, 424. 19</u>
Completing two new mud scows.....	2, 956. 82
Trimming canal wall and rock below	624. 26
Excavation of channel, lower entrance	477. 98
Building new middle gates.....	4, 973. 93
Extension of city water-pipes	40. 00
Aggregate	<u>64, 497. 18</u>

Statement showing cost of passing boats and freight through canal for the fiscal year ending June 30, 1891, under ordinary running expenses.

Per lockage.....	\$8. 47 +
Per boat.....	5. 66 +
Per ton .....	. 02 $\frac{1}{2}$ +

Statement of expenditures for operating and care of Louisville and Portland Canal for the fiscal year ending June 30, 1891.

Office and general administration:	
Salaries	\$5, 128. 75
Supplies	456. 99
Miscellaneous	755. 84
Total	<u>6, 041. 58</u>
Canal and locks:	
Labor	21, 562. 32
Supplies	2, 982. 41
Repairs and extra labor	3, 156. 10
Total	<u>27, 640. 83</u>
Dredging:	
Labor	11, 419. 18
Supplies	4, 028. 68
Repairs	6, 293. 92
Total	<u>21, 741. 78</u>
Grand total	<u>55, 424. 19</u>
Completing two new mud-scows.....	2, 956. 82
Trimming canal wall and rock below	624. 26
Excavation of channel, lower entrance to canal	477. 98
Building new middle gates.....	4, 973. 93
Extension of city water-pipes	40. 00
Aggregate	<u>64, 497. 18</u>

2398 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of proposals for furnishing and delivering forage at the Louisville and Portland Canal, received in response to the advertisement dated May 14, 1891, and opened June 13, 1891, by Maj. G. J. Lydecker, Corps of Engineers.

Articles.	Quantity (more or less).	1. Bid of George Becker and S. Beville.	* 2. Bid of B. B. Connor.
Best timothy hay.....pounds	10,000	†\$0.80	†\$0.80
Best black oats.....bushels	300	.55	.48
Best middlings bran.....pounds	600	†.80	†1.00
Best ear corn.....bushels	100	.68	.60
Best wheat straw.....pounds	100	†.50	†.50
Total cost.....		328.30	290.50

* Recommended for acceptance.

† Per hundredweight.

Abstract of proposals for coal, received in response to the advertisement dated May 14, 1891, and opened June 13, 1891, by Maj. G. J. Lydecker, Corps of Engineers.

No.	Name of bidder.	Kind of coal.	Quantity (more or less).	Price.
*1	Austin H. Dugan..	Best Pittsburg.....bushels..	10,000	\$0.11
		Second Pool Pittsburg.....do..	900	.11
		Ohio River or Kanawha.....do..	34,000	.09
		Anthracite, egg.....tons..	8	7.25
		Anthracite, nut.....do..	8	7.25
		Total cost.....		4,375.00

* Recommended for acceptance.

Statement showing amount and cost of excavation by dredging during the fiscal year ending June 30, 1891.

Time at work.....days..	351
Cubic yards excavated.....number..	100,585
Cubic yards excavated per day.....do..	286

Cost:	
Wages for the year.....	\$11,419.18
Repairs and supplies for the year.....	10,322.60
Total.....	21,741.78
Wages per day for year.....	31.28
Repairs and supplies per day.....	28.81
Cost per actual working day.....	61.94
Cost per cubic yard excavation.....	0.21

Statement of dredging during the fiscal year ending June 30, 1891.

	Working days.	Scows.	Cubic yards.
Dredge No. 1.....	184	982	47,585
Dredge Louisville.....	167	921	52,990
Total.....	351	1,903	100,585

REPORT OF MR. R. R. JONES, ASSISTANT ENGINEER.

LOUISVILLE, KY., *June 30, 1891.*

MAJOR: I have the honor to submit the following report of operations for the care of the Louisville and Portland Canal for the fiscal year ending June 30, 1891:

NEW GUARD GATES, OLD AND NEW LOCKS.

No work was done in the construction of these gates, the old ones being in a condition to use for another season by making slight repairs.

NEW MIDDLE GATES, NEW LOCKS.

The completion of these gates has been delayed by the difficulty of obtaining the oak timber required, but a large amount of work has been done in dressing and framing the timber received. All the castings for the gates have been delivered ready for use.

The wrought-iron truss rods, straps, and bolts are also practically completed.

About sixty pieces of oak timber are required to complete both gates, and as soon as they are delivered the gates can be put together ready for launching.

After the gates have been launched they will be towed into the lock, the old gates removed, and the new ones erected in their place with as little delay as possible.

The new gates will each be 47.75 feet long and 32.875 feet high. The top of the new gates will be 2 feet higher than the old gates originally were, and will reach elevation 48.45. By raising the timber coping on the lock wall, now at elevation 47.70, to the extent of 0.75 foot, the upper lock can be operated up to a stage of water equal to 13.45 feet on upper gauge of canal.

REVETTING LOWER END OF RIVER BANK.

No work has been done under this head during the year.

MUD SCOWS.

Two new mud scows for removing dredged material from the canal have been completed and put into service. These boats are each 85 feet long, 25 feet wide, and their hoppers contain 100 cubic yards of mud. The boats have been very strongly built and answer the purpose for which they were constructed.

Two of the old mud scows have been thoroughly rebuilt and the hoppers enlarged so that they now contain about 50 cubic yards of material, an increase of about 10 cubic yards over their former carrying capacity.

The increase of carrying capacity in both new and old scows has greatly facilitated the work of dredging in canal as each trip of the towboat conveys a greater quantity of material to the dumping ground with no increase cost for fuel or labor. The two remaining old scows should be rebuilt during the coming fiscal year in order to have a reserve against possible accident to the boats already in use.

WORK OF TRIMMING CANAL WALL.

Out of the appropriation of \$1,000 for performing this work, about two-thirds have been expended in dressing off roughly projecting portions of the canal wall. The work can only be prosecuted during comparative low stages of water, and has been thrice interrupted during the fiscal year by sudden rises in the river.

If a low stage of water should prevail during the present season, the work, which is of great importance to boats using the canal, can be resumed. This work is done by stonecutters working from a raft in the canal.

EXCAVATION OF CHANNEL, LOWER ENTRANCE.

The water was too high during the fiscal year to permit of drilling and blasting the rock in channel at lower entrance to canal. When the river commenced falling everything was put in readiness to begin work, even to the procurement of dynamite and exploders, but just as the working stage was neared the river rose again and prevented the prosecution of the work.

DREDGING IN CANAL, ETC.

The United States towboat and two dredges have been engaged in the removal of mud from the canal and approaches thereto, as shown in the statements submitted herewith.

2400 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

A high average stage of water prevailed during the spring of 1891, as was the case during the year 1890.

On the falling of the river a large bar made its appearance in the river opposite and above the mouth of the old locks. As the river continued to fall the sand from this bar was cut out, swept down by the current and deposited in the channel at lower entrance of new locks.

It has only been by the most persistent effort that a channel for the passage of boats to and from the new locks could be maintained. The channel was repeatedly dredged out only to be refilled with sand from above. A single night would suffice to fill in from 3 to 6 feet of sand in what the day before had shown good water.

It is believed that the present broken down condition of the low dam leading from the head of Sand Island to the Indiana shore is responsible in part for the deposit of sand at this point.

Repairs to the dam now in contemplation will direct a greater volume of water to the south channel, and thereby effect a scouring before the river reaches a very low stage.

UNITED STATES TOWBOAT.

The towboat was placed in dry dock, her hull examined and calked and rudders repaired. The guards have been repaired, new irons placed on nosing, new mud and steam drums put in place, and the exterior of the boat painted. Other slight repairs were made from time to time as necessary.

DREDGES.

Ordinary repairs made to both dredges as required, and a new canvas covering placed on the roof of the *Louisville*.

BARGES AND SMALL BOATS.

Slight repairs were made to these boats as required.

DRY DOCK.

The dry dock has been used by outside parties for the purpose of repairing steamboats, barges, etc. Ten steamboats and 10 barges have used the dock for a period of 57 days, 18 hours paying therefor dockage fees amounting to \$677.49. For the purpose of repairing boats, etc., belonging to this work the dock has been occupied for a period of 20 days.

BRIDGES.

A new upper floor of Georgia pine was laid on the Eighteenth Street Bridge, May 29, 1891. Temporary repairs were made to the flooring and joists of the bridge at the new locks. Lumber has been received for replacing the entire floor on this bridge, and the first favorable opportunity will be taken for doing this work.

Both of the iron swing bridges at Eighteenth Street and the new locks are weak, and should be replaced at an early day by modern wrought-iron structures capable of sustaining the heaviest loads which can ever pass over them. All the compressive members of the present bridges are cast iron; the floor systems are badly designed, and the connections generally are imperfect and of such a character that the strength of the bridges is greatly impaired.

A sudden impact from a very heavy load might cause a fracture and the total collapse of either or both of the present bridges.

SHOPS AND OTHER BUILDINGS.

The shops, storehouses, etc., have been repaired when necessary, and the framing shed painted.

The engine houses and shelter sheds at the new locks have been painted. The house at the locks, originally built for a toll collector, when tolls were enforced, has been repaired by putting on a new tin roof, and minor repairs to the siding.

OLD REVETMENT WALL.

A section of the old revetment of bank along the lower new lock having fallen down was carefully rebuilt, the stone being built in with cement. Other sections of the same wall will have to be rebuilt during the present fiscal year.

LOCK GATES AND MACHINERY.

Small repairs have been made as required. The old guard-gate, at head of canal, having been condemned was torn out and taken apart, the timber and ironwork being utilized for other purposes.

NEW FENCE.

The old picket fence along the crest of the canal, bank on south side of canal from new locks to Fourteenth Street Bridge, had fallen in decay and was replaced by a fence of galvanized barbed wire, 5 feet high, eight strands of wire, secured to oak posts placed 12 feet apart.

STAGES OF WATER IN RIVER AND CANAL.

The highest stage of water occurred February 27, 1891, when there were 32.4 feet on upper, and 58 feet on lower, gauge of canal.

The lowest water was on August 6, 1890, when the same gauges showed 3.6 feet and 7.5 feet, respectively.

Very respectfully, your obedient servant,

R. R. JONES,
Assistant Engineer.

Maj. G. J. LYDECKER,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Statement of vessels passed through the Louisville and Portland Canal during the fiscal year ending June 30, 1891.

Vessels.	No.	Tons.
Passenger-boats	590	228, 333
Towboats	836	91, 048
Government boats	67	6, 598
Coal boats and barges	3, 197	854, 654
Small craft	187	
Total	4, 877	1, 180, 633
Logkages	3, 261	

Statement of commerce passed through the Louisville and Portland Canal during the fiscal year ending June 30, 1891.

Articles.	Tons.	Articles.	Tons.	Articles.	Tons.
Coal	1, 005, 796	Lumber	2, 728, 103	Flour	1, 045
Oil	2, 451	Corn	1, 472	Sugar and molasses ..	6, 236
Salt	5, 676	Wheat	2, 748	Hay and straw	6, 653
Whisky	1, 366	Iron ore	3, 681	Stock	11, 922
Tobacco	4, 093	Steel rails	29, 433	Staves and shingles ..	23, 670
Cotton	8, 981	Produce	8, 416	Miscellaneous	92, 802

Comparative statement of commerce passed the Falls of the Ohio River by canal and by river.

Fiscal years.	Vessels through canal.		Vessels, open river.				Total.	
			Descending.		Ascending.			
	No.	Tons.						
1881-'82	3,964	904,343	1,793	537,906	750	220,965	6,507	1,663,214
1882-'83	4,954	1,226,455	1,294	398,240	179	61,802	6,427	1,686,497
1883-'84	4,346	1,070,650	1,384	432,575	301	98,757	6,031	1,611,982
1884-'85	4,886	1,217,231	708	231,695	95	24,320	5,689	1,473,246
1885-'86	5,057	1,254,332	1,296	408,619	373	102,536	6,726	1,765,497
1886-'87	4,768	1,157,250	1,793	991,974	667	290,507	7,228	2,439,731
1887-'88	5,471	1,315,851	1,514	863,237	361	137,230	7,340	2,316,318
1888-'89	6,838	1,815,986	893	333,081	102	87,850	7,833	2,236,317
1889-'90	3,940	840,700	2,687	1,358,174	191	449,357	7,818	2,648,231
1890-'91	4,877	1,180,633	1,889	946,357	777	333,849	7,543	2,480,839

Principal items of commerce passed over the falls and through the canal during the fiscal year ending June 30, 1891.

Articles.	Tons.	Articles.	Tons.	Articles.	Tons.
Coal.....	1,683, 138	Iron.....	9, 137	Malt.....	171
Salt.....	7, 452	Steel rails.....	81, 125	Corit-wood.....	435
Oil.....	3, 909	Produce.....	8, 868	Peanuts.....	575
Whisky.....	1, 996	Flour.....	1, 373	Cross ties.....	800
Tobacco.....	6, 221	Sugar and molasses.....	9, 473	Firebrick.....	1, 425
Cotton.....	12, 866	Hay and straw.....	9, 400	Clinkers.....	350
Lumber.....	2, 735, 222	Stock.....	15, 294	Sewer pipe.....	110
Corn.....	2, 286	Staves and shingles.....	32, 514	Miscellaneous.....	103, 671
Wheat.....	2, 933	Cement.....	7, 018		
Iron ore.....	4, 017	Vinegar.....	5		

H H 4.

IMPROVEMENT OF WABASH RIVER, INDIANA AND ILLINOIS.

The improvement of this river has heretofore been considered and appropriated for in two sections, viz: Improvements below Vincennes, and improvements above Vincennes. The project in both cases is the same, and aims at securing a navigable low-water channel of 3 feet, and the operations to that end include the excavation of channels through rocky reefs, the concentration of flow in a single channel by closing all secondary channels, river contraction by the construction of dikes and spurs, bank protection where needed, and the removal of snags. The single work of any magnitude is the construction of a lock and dam on the Lower Wabash, near Mt. Carmel, Ill.

IMPROVEMENTS BELOW VINCENNES.

The principal work on this portion of the river is the lock and dam near Mt. Carmel, Ill., and most of the work done during the past year was applied thereto, though no great progress was made because of lack of funds during the working season of 1890; when the money appropriated by the act approved September 19, 1890, became available, the stone required for completing the lock was contracted for and its delivery at Mt. Carmel completed June 1, 1891, whence it was boated to the site of the work, $2\frac{1}{2}$ miles above. Masonry work was resumed June 25, and is now well under way. The total amount of masonry in the work June 30, 1891, was 6,090 cubic yards, of which 449 cubic yards was laid during the past fiscal year.

No work has been done on the dam, but a contract for stone required for the abutment on the shore opposite the lock has been entered into and its delivery has commenced. Derricks and tool houses have been erected preparatory to commencing the work of construction.

The only other work done during the past year comprised the removal of a few dangerous snags on the section of the river between Mt. Carmel and Coffee Chute; and some protection work in the vicinity of Grayville, where a dangerous cut-off has been threatened for several years past. The levee heretofore built in this vicinity was extended 1,750 feet during the year, making its total length at the close of the year 6,080 feet, and the number of spur dikes was increased by three, making the total now there ten.

During the present season it is expected to complete the lock and the abutment for the dam, and some snags may be removed from the lower

river, but the funds available will not permit much work of that nature.

It is of the utmost importance that the next appropriation be sufficient to complete the dam at Grand Rapids, near Mt. Carmel, because if once commenced it should be pushed through to completion, in order to avoid risk of destruction to the unfinished structure during any period of suspension.

Besides, no benefit can be realized from the lock, now nearly finished, until this dam is built. The estimated cost of the dam is \$60,000; the further sum of \$40,000 is urgently needed to clear this section of snags and close the most harmful cut-offs, and open channels through the worst shoals.

The inclosed report of O. L. Petitdidier, assistant engineer, in local charge of this work, gives in more detail the operations of the year, and supplies the commercial statistics relating to the Lower Wabash.

Money statement.

July 1, 1890, balance unexpended	\$11,955.34
Amount appropriated by act approved September 19, 1890.....	60,000.00
	<hr/> 71,955.34
June 30, 1891, amount expended during fiscal year.....	30,154.57
	<hr/> 41,800.77
July 1, 1891, balance unexpended.....	
July 1, 1891, outstanding liabilities.....	\$1,590.54
July 1, 1891, amount covered by uncompleted contracts	6,541.80
	<hr/> 8,132.34
July 1, 1891, balance available	33,668.43
(Amount (estimated) required for completion of existing project	100,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893.	100,000.00
{ Submitted in compliance with the requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for furnishing stone for the construction of abutment for dam in the Wabash River, received in response to the advertisement dated March 30, 1891, and opened April 29, 1891, by Capt. Edw. Maguire, Corps of Engineers.

[Quantities in cubic yards and price per cubic yard, delivered at railroad switch near the river, at Mount Carmel.]

No.	Name of bidder.	Special stone.		Coping.		Cut stone, quarry face.	
		Quantity.	Price.	Quantity.	Price.	Quantity.	Price.
1	Romona Oolitic Stone Co.*.....	18	\$11.50	52	\$11.50	189	\$10.10
2	Salem Stone and Lime Co.†.....	18	12.05	52	13.30	189	12.05
3	Salem Stone and Lime Co.†.....	18	11.00	52	12.25	189	11.00
4	The Dark Hollow Quarry Co.....	18	12.55	52	11.55	189	11.30
5	George F. Branham §.....	18	10.58	52	10.58	189	9.00

No.	Name of bidder.	Cut stone, pointed face.		Squared stone.		Backing.		Total cost.
		Quantity.	Price.	Quantity.	Price.	Quantity.	Price.	
1	Romona Oolitic Stone Co.*.....	60	\$10.10	235	\$10.10	101	\$8.40	\$6,541.80
2	Salem Stone and Lime Co.†.....	60	12.05	235	11.75	101	10.70	7,750.00
3	Salem Stone and Lime Co.†.....	60	11.00	235	10.65	101	9.60	7,046.35
4	The Dark Hollow Quarry Co.....	60	11.55	235	9.60	101	8.30	6,796.50
5	George F. Branham §.....	60	9.00	235	7.25	101	6.85	5,377.20

* Accepted.

† Sample of even color.

‡ Sample of uneven color.

§ No sample submitted.

2404 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of proposals for furnishing stone for lock in Wabash River, received in response to the advertisement dated October 21, 1890, and opened November 20, 1890, by Capt. Edw. McGuire, Corps of Engineers.

[Quantities in cubic yards and price per cubic yard, delivered at railroad switch near the river, at Mount Carmel, Ill.]

No.	Name of bidder.	Special stone.		Coping.		Cut stone, dressed face.	
		Quan- tity.	Price.	Quan- tity.	Price.	Quan- tity.	Price.
1	Romona Oolitic Stone Co	79	\$16.20	236	\$12.15	396	\$11.88
2	Salem Stone and Lime Co	79	16.50	236	16.00	396	13.50
3	Dark Hollow Quarry Co	79	14.75	236	13.25	396	13.25

No.	Name of bidder.	Squared stone.		Backing.		Total cost.	Remarks.
		Quan- tity.	Price.	Quan- tity.	Price.		
1	Romona Oolitic Stone Co	378	\$10.26	289	\$8.64	\$15,226.92	Stone does not come up to requirements of specifications.
2	Salem Stone and Lime Co	378	12.00	289	11.12	18,175.18	Recommended for acceptance.
3	Dark Hollow Quarry Co	378	11.50	289	9.50	16,631.75	

EXTRACT FROM REPORT OF MR. O. L. PETTIDIER, ASSISTANT ENGINEER.

MOUNT CARMEL, ILL., June 30, 1891.

MAJOR: I have the honor to present the following report on the improvement of the Wabash River, Indiana and Illinois (below Vincennes), during the fiscal year ending June 30, 1891:

The works carried on during the last fiscal year have been the work of bank protection at Grayville, Ill., the construction of the lock at Grand Rapids, the receiving and boating of stone from Mount Carmel to the site of the lock, and the removal of a few snags and rocks from the channel.

GRAYVILLE BEND CUT-OFF, 62 MILES FROM MOUTH OF RIVER.

The object of work at this place has been the protection of bank and prevention of a threatened cut-off at a point 2 miles above the town of Grayville.

The cut-off would have not only shut off the large sawmills and town of Grayville from the river, but would also have caused a deterioration of the river by increasing the surface slope within a very short distance.

The work done at Grayville has consisted at first of the protection of caving river bank by means of piling brush and stone, and later on by means of spur dikes extending from the bank at right angles to the current, this being supplemented with a levee across the incipient cut-off, and extending on either side for a considerable distance.

The work during the past fiscal year has consisted of the construction of the three additional spur dikes and extension of levee some 1,750 feet further east.

Six thousand and twenty-one linear feet of timber, 1,500 pounds of iron, and 450 cubic yards of stone have been used in the construction of the spur dikes; while 18,662 cubic yards of earth have been used in the construction of extension levees.

The cost of earthwork in levee has been quite low, being nearly 13½ cents per cubic yard; the work being done by means of scrapers; the total amount spent last year being nearly \$4,000.

The work at Grayville Bend consists now of 6,080 feet of levee completed and in good order, the former piling, rock and brush protection, and 10 new spur dikes.

The work seems to be completed, or at least in such shape that it can be let alone until further action of the river demands additional work in a new direction.

The nature of the alluvial banks as regards shape of bend and direction of current during high water, friability, and submergence during freshets is such, however, that we can not feel certain at any time but that a new cut-off may not take place at some point not yet protected.

The land owners contiguous to our levee keep demanding a further extension of

levee, urging the presence of erosions, which have already taken place, as indications of a possible new cut-off.

It is probable that an extension of levee of 500 or 600 feet additional might give us a greater security against the failure of work already done, but this I do not feel like urging or even recommending until you have had the opportunity of seeing the ground.

There is no doubt that the extension of levee would benefit the property owners whose land is now threatened, but I see no reason why the same reasoning would not cause us to extend the levee a little at a time, clear to the hills, 4 or 5 miles away, in the mean time crossing with our levee several bayous.

Should additional funds become available it would be proposed to extend the works of bank protection and possibly to build a low, crib dike from the bank to the tow head of Bon Pas Island, in order to direct the channel on the north side of island.

LOCK AND DAM AT GRAND RAPIDS, 92½ MILES ABOVE MOUTH OF RIVER.

The work at this place, consisting of a lock and dam at Grand Rapids, 2½ miles above Mount Carmel, Ill., is to take the place of a former lock and dam built by the Wabash Navigation Company in 1843, the old lock and dam built of crib work having been partially washed away.

When completed this dam will raise the level of the water 11.50 feet above the level of water at lower end of lock and will at once remove the greatest obstruction to navigation on the Wabash River, which consists of a chain of rocks beginning at Grand Rapids and cropping out in several places for a distance of 10 miles, actually cutting the navigation of the Wabash River in two, except at high-water stages.

The lock, which was well advanced at beginning of fiscal year, has, owing to want of sufficient funds to purchase the remainder of stone, not been completed, and we have had to content ourselves with laying whatever stone we had on hand, until such time as new appropriations became available.

The money appropriated by act of September 19, 1890, becoming soon available, a contract for stone to complete the lock was entered into with the Dark Hollow Quarry Company, of Bedford, Ind., on November, 20, 1890; delivery of stone was completed by June 1, 1891, and the stone transported to the lock by means of our boat and barges.

The laying of masonry was resumed on June 25, and is now progressing at an average rate of 40 to 45 cubic yards per day.

A contract for stone for the abutment of dam on the side of the river opposite to the lock was entered into with the Romona Oolitic Stone Company, Romona, Ind., and stone is now being furnished by them, the delivery to be completed by September 1, 1891.

Specifications for timber for lock gates are now being considered by various dealers in timber.

The work done in connection with the lock has been as follows:

	Cubic yards.
Masonry laid.....	449
Masonry laid previously reported.....	5,641
Total masonry laid to date.....	6,090
Remaining to be laid, approximately.....	1,400
Stone received during the year.....	1,322
Stone received previously reported.....	4,798.2
Total stone received.....	6,120.2
Stone transported to the lock during year.....	1,322

In addition to the masonry work reported, the upper miter sill and lift wall have been bolted to the lower courses by 1½ inch bolts 5 feet long laid in cement.

The filling and emptying culverts have been lined on the bottom with two thicknesses of 2-inch white oak sheeting, securely spiked to floor beams set in the rock and reaching under the walls on either side; 4,746 feet B. M. of oak were used in lining the bottom of culverts.

Repairs to our engines, derricks, traveler track and storehouses have also been made.

The work intended to be done during the present fiscal year at the locks or in connection therewith, is as follows:

Completion of land wall of lock, filling up of bank behind wall, and paving same;

construction and erection of lock gates and of valves for operating, filling, and emptying culverts, cleaning lock chamber, and finishing all work about the lock except the dredging at the head and foot.

On the opposite side of the river it is intended to build a masonry abutment, for which purpose two derricks and a cement house have already been erected.

The work enumerated above will nearly exhaust the funds on hand, and additional appropriations must be available before the dam (without which all the money spent here will be useless) can be even begun.

Our present estimate for the construction of the dam, which will be 1,095 feet long, is \$58,460, and after pondering over all the quantities and prices, I am unable to reduce the estimate to any smaller figures. It follows that if it is intended to complete the improvement that our next appropriation to be applied specifically to the dam should not be less than \$60,000.

Such a sum would, I am very confident, complete the improvement.

From the nature of the work and the materials that will enter into the construction of the dam, it is essential that the work be completed in one season, and this can not be done unless the whole amount estimated is appropriated at one time. Should the next appropriation for this work fall short of the amount estimated it will be necessary to suspend work and wait until by means of successive future appropriations the amount on hand has been brought to the amount required by the estimate.

In the mean time the price of timber upon which this estimate is based can not fail to advance with every year's delay and thus cause an increase of our estimate.

The fact that until our dam is completed all the money spent at the lock and abutment will be unproductive of any good to the interests of navigation must also have a certain weight.

REMOVAL OF SNAGS.

During the fiscal year some dangerous snags between the bridge at Mount Carmel and the foot of Coffee Chute were removed with the aid of the *Richard Ford*; several large boulders were also removed from the foot of Coffee Chute.

The amount expended in doing this work was about \$111. The funds on hand at the time did not allow of the boat going out any longer.

During the spring of 1891 the *Richard Ford* was used in towing the stone for lock from Mount Carmel to the site of lock, being engaged in the work for 17 working days. This boat, after undergoing various necessary repairs, is now ready for work, it being the intention to have her remove all the snags between Mount Carmel and the mouth of river which may be found in the channel. As the *Richard Ford* belongs to the White River, it is intended after completing the above work to put her in commission for a portion of the fiscal year in that river.

CONDITION OF RIVER.

There having been but very little work done on the lower river during last fiscal year, the condition of river a low water, as reported in my last annual report, has not improved.

Additional snags are reported in various places, especially at foot of Little Chain and Blacks Cut-off. Considerable complaint also comes from New Harmony Cut-off, which is each year absorbing a larger portion of the discharge of the main river, so that at low water the channel around Ribeyre Island is impassable. No project for an attempt at improvement is submitted, beyond the removal of snags or loose rocks which may be in the channel, for the reason that it is believed that all our energies or funds on hand should be turned toward the completion of lock and dam at Grand Rapids.

The amount of commerce done on the Lower Wabash River during the last fiscal year shows an increase in the value of the products carried, in fact more than double, this increase of value being due to the larger proportion of grain carried.

By far the greatest portion of the commerce was done during the high water of February, March, and April, 1891.

I forward herewith commercial statistics of the Lower Wabash, together with comparative statistics of the commerce done both on Upper and Lower Wabash for the last five years.

Very respectfully submitted.

Your obedient servant,

O. L. PETTIDIER,
Assistant Engineer.

Maj. G. J. LYDECKER,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

List of steamboats (stern-wheel) plying on Wabash River below Vincennes during fiscal year ending June 30, 1891.

Names.	Tonnage.	Where plying.
Rosedale.....	256	New Harmony and mouth.
Cumberland.....	400	Mount Carmel and points to the mouth of river.
Eugene.....		Occasional trips.
Emma Cooper.....		Do.
E. S. Ragon.....		Do.
J. P. Drouillard.....		Do.
Gus Gennin.....		Do.
D. A. Nesbit.....		Do.
Diana.....	60	Mount Carmel and White River.

Commercial statistics of Wabash River below Vincennes, fiscal year ending June 30, 1891.

	Tons.
Grain.....	21,423
Lumber and logs.....	33,500
Dimension stone.....	2,842
Sand.....	2,816
Total.....	60,581

Comparative statement of commerce on Wabash River, Indiana and Illinois.

Years.	Tons.	Approximate value.
1887.....	122,729	\$1,817,947
1888.....	58,014	535,006
1889.....	106,513	1,573,698
1890.....	100,443	641,107
1891.....	103,415	1,162,299

IMPROVEMENTS ABOVE VINCENNES.

There has been no work done on this portion of the river during the past fiscal year, because there was not sufficient funds on hand at the beginning of the year, and the appropriation by the act approved September 19, 1890, came too late to be used to advantage. Navigation on this section is now badly obstructed by snags, and it is proposed to do as much toward their removal as the funds on hand will permit; but the snagging outfit is in such a dilapidated condition that considerable repairs must be made thereto before any work can be done on the river itself, and these repairs will call for an expenditure of no less than half the available appropriation.

It is estimated that an expenditure of \$20,000 will remove the principal obstructions to navigation now complained of, and if it is proposed to give the benefits of such improvement this amount should be appropriated for the next fiscal year, and thereafter an annual appropriation of about \$5,000 for the removal of snags and maintenance of dams, shore protection, etc.

Extracts from the report of Mr. O. L. Petitdidier, assistant engineer, with commercial statistics relating to this section of the river, are transmitted herewith.

2408 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Money statement.

July 1, 1890, balance unexpended.....	\$251.78
Amount appropriated by act approved September 19, 1890.	5,500.00
	<hr/>
June 30, 1891, amount expended during fiscal year.....	5,751.78
	9.52
	<hr/>
July 1, 1891, balance unexpended.....	5,742.26
July 1, 1891, outstanding liabilities.....	6.86
	<hr/>
July 1, 1891, balance available	5,735.41
	<hr/>
{Amount (estimated) required for completion of existing project.....	20,000.00
{Amount that can be profitably expended in fiscal year ending June 30, 1893.	20,000.00
{Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

EXTRACT FROM REPORT OF MR. O. L. PETITDIDIER, ASSISTANT ENGINEER.

MOUNT CARMEL, ILL., June 30, 1891.

MAJOR: I have the honor to present the following report upon the improvement of the Wabash River above Vincennes for the fiscal year ending June 30, 1891:

The portion of Wabash River, above Vincennes, upon which improvements have been made, is 90 miles in length. The project has aimed at obtaining a depth of 3 feet at low water by means suited to the various localities and by the removal of snags.

The project for the last fiscal year contemplated the removal of snags from the channel, but there being but a small unexpended balance at the beginning of the year and the new appropriation becoming available too late last fall to commence work, no work was done on the Upper Wabash during the last fiscal year.

CONDITION OF THE RIVER.

There having been no work done during the past year I can only say that the conditions reported last year have been intensified, and that the river is now encumbered by numerous snags, which lodge during every freshet in the locations already the most restricted.

Several boats are still plying above Vincennes regularly. The quantity of commerce carried by them is considerable, and although showing a small decrease of business may not necessarily be due to decrease of importance of the river, but to the lowness of water at the time when crops must be moved.

PROJECT.

It is intended at as early a date as practicable to put a snag boat in the field and begin to remove the snags.

Unfortunately the steamer *Oaseo*, with which we used to tow the snag scow belonging to the Upper Wabash, is now beyond repair, while the snag scow itself will require a considerable outlay before it is ready for service.

I forward with this report tabular statements showing the amount of commerce carried on the river during the past fiscal year.

Very respectfully submitted.

Your obedient servant,

O. L. PETITDIDIER,
Assistant Engineer.

Maj. G. J. LYDECKER,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

List of steamboats (stern-wheel) plying on Wabash River above Vincennes during fiscal year ending June 30, 1891.

Names.	Tonnage.	Where plying.
Janie Ray	125	Vincennes to Terre Haute.
Cumberland	400	Do.
Diana	60	Terre Haute and Hutsonville.
Eugene		Occasional trips.
Emma Cooper		Do.
J. H. Russel	75	Vincennes to Hutsonville.

Commercial statistics of Wabash River above Vincennes, fiscal year ending June 30, 1891.

Merchandise.....	tons..	923
Grain.....	do...	6,004
Lumber by steamboat	do...	908
Lumber and logs rafted.....	do...	35,000
Passengers.....	number..	6,984

H H 5.

IMPROVEMENT OF WHITE RIVER, INDIANA.

Operations on this river have aimed at securing a navigable low-water channel, with a depth of 3 feet, by excavation through rocky chains and sandy shoals, and the construction of dikes and dams, but doubt is expressed whether any substantial improvement can be maintained without resorting to the more radical improvement by the construction of locks and dams.

At the beginning of the last fiscal year the balance available was \$5,205.66, but its expenditure was prohibited until the bridges over the river had been changed so as not to obstruct navigation; this restriction was removed by the river and harbor act, approved September 19, 1890, but it was then too late in the season, and the stage of river was too unfavorable to justify the commencement of operations. Accordingly there was no work done during the past fiscal year.

The two bridges which were reported as obstructions were the railroad bridges near Hazelton and Rodgers, Ind. The former has been provided with a suitable draw, and no longer interferes with navigation; the latter remains unchanged.

During the ensuing working season it is proposed to apply about one-half of the money available to completing the improvement at Kelley Ripple by rock excavation at the head of the channel already excavated, and the extension of the south dike on the channel line to the left bank of the river. The remainder of the appropriation will be applied to snagging.

Under the present system of improvement it is estimated that an appropriation of \$12,500 to be applied to dredging and clearing the river of snags, would serve to clear the river of the worst remaining obstructions; the appropriation of this amount is therefore recommended.

Extracts from the report of Mr. O. L. Petitdidier, assistant engineer, transmitted herewith, indicated the present condition of the river and furnish the statistics of its commerce.

2410 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Money statement.

July 1, 1890, balance unexpended	\$5, 205. 66
June 30, 1891, amount expended during fiscal year	30. 34
July 1, 1891, balance unexpended	5, 175. 32
{ Amount (estimated) required for completion of existing project	12, 500. 00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	12, 500. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

EXTRACTS FROM REPORT OF MR. O. L. PETITDIDIER, ASSISTANT ENGINEER.

MOUNT CARMEL, ILL., *June 30, 1891.*

MAJOR: I have the honor to present the following report on the improvement of White River, Indiana, during the fiscal year ending June 30, 1891:

CONDITION OF THE RIVER.

The condition of the river at low water is far from being satisfactory, not only on account of the numerous snags which have not been removed for several years, but mainly for the reason that at low water the depth of water over the shoals is insufficient for the only class of boats whose operation can be made a success commercially.

True the depth of water at Kelly Ripple, where the main improvement has taken place, has been increased permanently so that boats drawing 2 feet can pass through it at any time, but the available depth both above and below has not been increased correspondingly, neither can it, in my estimation, be increased except by such means as locks and dams.

The bridge operated by the Evansville and Terre Haute Railroad, near Hazelton, which has for years been a total obstruction to navigation at low water, has been provided during the fiscal year with a draw suitably located so that boats can pass this point at any time.

The railroad bridge at Rodgers is still unprovided with a draw, but it does not appear at present that the interests of navigation are suffering thereby.

The commerce done on the White River during the past fiscal year, although far from being inconsiderable, seems to show a falling off from the statistics given the previous year. No special importance is attached to this, however, as the transportation of grain by the river route depends almost entirely upon the stage of water, at the time the crops are ready to be moved.

Tabular statements showing the amount of commerce done during last fiscal year, also comparative commercial statistics for the last 5 years, are forwarded with this report

During the present fiscal year it is intended to expend the funds on hand in completing the improvement at Kelly Ripple and in removing the snags in the channel. The water is now at a favorable stage and work will begin in a few days.

Very respectfully, your obedient servant,

O. L. PETITDIDIER,
Assistant Engineer.

Maj. G. L. LYDECKER,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

List of steamboats (stern-wheel) plying on White River, Indiana, during fiscal year ending June 30, 1891.

Name of boat.	Tonnage.	Where plying.
Eugene .....	.....	Hazelton to mouth.
Emma Cooper .....	.....	Do.
Diana	60	Petersburg to mouth.
J. H. Russell	75	Do.

Commercial statistics of White River, Indiana, fiscal year ending June 30, 1891.

	Tons.
Grain	2, 007
Logs and lumber "rafted"	13, 025
Total	15, 632

Comparative statement of commerce on White River, Indiana.

Years.	Tons.	Approximate value.
1887	42, 650	\$181, 000. 00
1888	6, 400	71, 145. 00
1889	27, 000	137, 950. 00
1890	29, 409	256, 330. 00
1891	15, 032	93, 150. 00

H H 6.

PRELIMINARY EXAMINATION OF WABASH RIVER, INDIANA, FROM TERRA [TERRE] HAUTE TO LA FAYETTE, WITH A VIEW OF REMOVING OBSTRUCTIONS OF SNAGS AND BARS AND REESTABLISHING THE NAVIGATION OF SAID RIVER BETWEEN THESE CITIES.

[Printed in House Ex. Doc. No. 65, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 5, 1890.

SIR: I have the honor to submit herewith the accompanying copy of report dated November 24, 1890, from Capt. Edward Maguire, Corps of Engineers, giving results of preliminary examination of Wabash River from Terre Haute to La Fayette with a view of removing obstructions of snags and bars and reestablishing the navigation of said river between these cities, made to comply with provisions of the river and harbor act approved September 19, 1890.

Captain Maguire reports that, in his opinion, the stretch of the Wabash River referred to is not worthy of improvement. Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division, coincides in this opinion, and the views of these officers are concurred in by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF CAPTAIN EDW. MAGUIRE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., November 24, 1890.

GENERAL: In compliance with circular letter of September 20, 1890, I have to submit the following report, based upon a preliminary examination made under my direction by Assistant Engineer O. L. Petitdidier, of the Wabash River, Indiana, from Terre Haute to La Fayette, with a view of removing obstructions of snags and bars and reestablishing the navigation of said river between those cities.

The river between Terre Haute and La Fayette is approximately 107 miles in length, its normal width being about 300 to 350 feet in the upper half and 400 to 500 feet in the lower half of that reach.

At the time of examination the stage of the river was about 8 inches

above that of lowest water. In the upper 89 miles, which were passed over in a row boat, there were found to be twenty-nine sand and gravel bars. The depth over the majority of these bars was sufficient to permit of a boat drawing 12 inches being warped through the best channel, but in two or three cases a boat drawing 10 inches could hardly have been dragged through.

The upper 50 miles of the reach were almost free from snags, but the latter increased rapidly in size and number below Big Pine Creek, the mouth of which is about 60 miles below La Fayette.

The stretch of river under consideration is also crossed by a number of county road and railroad bridges unprovided with draws, or so located as to render navigation very difficult. At Attica, where three bridges are located near to each other, not only is navigation very difficult at any stage, but it is almost impracticable at low water on account of the large quantities of riprap protecting the foundations of the piers.

The number of bridges between La Fayette and Terre Haute are 9 in number, located as follows: 3 at Attica; 2 at Covington; 1 at Lodi; 1 at Montezuma, and 2 at Clinton. The 6 first mentioned are without draws, and the minimum clearance 30 feet 3 inches.

In addition to the above the remains of the piers of a former bridge obstruct the channel 4 miles above Covington. At present there is one small boat which navigates the stream, and that one was at the time of the examination tied up at Terre Haute waiting for a rise in the river.

The freight carried on the river is purely local and comparatively insignificant in amount and value. It consists of corn, wheat, staves, railroad ties, and some broken stone. The coal is carried by the railroad which skirts the river for the whole distance under consideration.

In view of the above my opinion is that the stretch of river referred to is not "worthy of improvement" for the following reasons:

(1) Owing to the obstructions due to bars and bridges navigation at low water is impracticable; at medium stage only very small steamboats can navigate the river; at high water the bridges are complete obstructions to any navigation.

(2) The stream flows through an alluvial region and its banks are low and easily washed. Hence any system of improvement looking to the production and maintenance of an unobstructed navigable channel would be so costly as to render it unworthy of consideration at present.

(3) The result of careful inquiries does not lead to the anticipation of any important increase in commerce, and hence "the present and prospective demands of commerce" are too slight to be worthy of consideration.

Very respectfully, your obedient servant,

EDW. MAGUIRE,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., November 28, 1890.

Respectfully forwarded, with report that I concur in the views of Captain Maguire as herein expressed.

O. M. POE,
*Colonel, Corps of Engineers,
Division Engineer, Northwest Division.*

APPENDIX I I.

IMPROVEMENT OF GREAT KANAWHA, ELK, AND GAULEY RIVERS, WEST VIRGINIA, AND OF NEW RIVER, VIRGINIA AND WEST VIRGINIA.

REPORT OF COLONEL WM. P. CRAIGHILL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|--|--|
| 1. Great Kanawha River, West Virginia.
2. Operating and care of locks and dams on Great Kanawha River, West Virginia. | 3. Elk River, West Virginia.
4. Gauley River, West Virginia.
5. New River, Virginia and West Virginia. |
|--|--|

EXAMINATION.

6. Elk River, West Virginia, with a view of improving the same by locks and dams.

(For letter of transmittal see Appendix I.)

I I I.

IMPROVEMENT OF GREAT KANAWHA RIVER, WEST VIRGINIA.

The object of the improvement has been to give a depth of not less than 6 feet all the year round throughout the whole river, 96 miles. The means are locks and dams. The locks are about 300 by 50 feet above Charleston, and about 340 by 55 feet below. The following table shows the present condition:

No.	Distance in miles from Charleston.	Style of dam.	Completed in—	Remarks.
2	26 miles above	Fixed	1887	In operation.
3	21 miles above	do	1882	Do.
4	15 miles above	Movable ..	1880	Do.
5	9 miles above	do	1880	Do.
6	4 miles below	do	1886	Do.
7	14 miles below	do		Under contract.
8	22½ miles below	do		Do.
9	32 miles below	do		Site purchased September, 1890.

2416 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of proposals for ironwork for anchorage and fixed parts of movable Dams Nos. 7 and 8 of the Great Kanawha River improvement, opened at the United States Engineer Office, Charleston-Kanawha, W. Va., at 4 p. m., February 10, 1891.

Approximate quantities:

Wrought iron.....	pounds..	94,000
Cast-iron.....	do.....	353,000

No.	Name and residence of bidder.	Wrought iron.		Cast-iron.		Total.
		Bid per pound.	Amount.	Bid per pound.	Amount.	Amount.
		<i>Cents.</i>		<i>Cents.</i>		
1	Ainslie, Cochran & Co., Louisville, Ky.....	3½	\$3,407.50	2½	\$8,825.00	\$12,232.50
2	American Bridge and Iron Co., Roanoke, Va.....	4	3,760.00	3.7	13,061.00	16,821.00
3	Hoedinghoff & Lane Foundry Co., Cincinnati, Ohio.....	4	3,760.00	2.4	8,472.00	12,232.00
4	McHose & Lyon Co., Dayton, Ohio.....	4	3,760.00	3.95	13,943.50	17,703.50
5	Lambert Bros. & Co., Ironton, Ohio.....	3.55	3,337.00	2½	10,148.75	13,485.75
6	Phoenix Iron Co., Trenton, N. J.....	4.55	4,277.00	3½	11,472.50	15,749.50
7	Bouton Foundry Co., Chicago, Ill.....	3.9	3,666.00	3.2	11,296.00	14,962.00
8	O. A. & W. Thayer, Charleston, W. Va.....	3.9	3,666.00	3½	11,472.50	15,138.50
9	Variety Iron Works Co., Cleveland, Ohio.....	3.75	3,525.00	2.85	10,060.50	13,585.50
10	Wm. H. March, Philadelphia, Pa.....	3.79	3,562.60	3.49	12,319.70	15,882.30
11	The Sneed & Co. Iron Works, Louisville, Ky.....	4.72	4,430.80	2.94	10,378.20	14,815.00
12	Russell Wheel and Foundry Co., Detroit, Mich.....	3.3	3,102.00	2.45	8,648.50	11,750.50
13	Campbell & Zell Co., Baltimore, Md.....	4½	4,465.00	3½	12,796.25	17,261.25
14	Cooper, Roberts & Co., Mount Vernon, Ohio.....	3.48	3,271.20	2.98	10,519.40	13,790.60
15	Scaffe Foundry and Machine Co., Pittsburg, Pa.....	7½	7,285.00	4½	15,885.00	23,170.00
16	Dearborn Foundry Co., Chicago, Ill.....	4.4	4,136.00	3.7	13,061.00	17,197.00
17	H. T. Morrison & Co., Petersburg, Va.....	4½	4,386.66	2½	8,236.67	12,623.33

Contract with the Russell Wheel and Foundry Company.

Abstract of proposals for building Dam No. 8, at the Great Kanawha River improvement, opened at the United States Engineer Office, Charleston-Kanawha, W. Va., at 3 p. m., February 10, 1890.

	Approximate quantities.	No. 1. C. Irwin McDonald, Pittsburg, Pa.		No. 2. Jally Brothers, Pittsburg, Pa.		No. 3. I. V. Hoag, jr., Pittsburg, Pa.	
		Bid.	Amount.	Bid.	Amount.	Bid.	Amount.
Gurbbing and clearing complete.....			\$100.00		\$100.00		\$400.00
Crib logs in cofferdam, per linear foot.....	79,000	\$0.19	15,010.00	\$0.22	17,380.00	\$0.20	15,800.00
Sheathing..... per 1,000 feet, B. M.....	50,000	30.00	1,500.00	35.00	1,750.00	30.00	1,500.00
Cofferdam filling..... per cubic yard.....	12,200	1.90	23,180.00	1.30	15,860.00	1.25	15,250.00
Excavation..... do.....	12,000	.65	7,800.00	.90	10,800.00	.75	9,000.00
Rock excavation..... do.....	800	3.00	2,400.00	3.00	2,400.00	2.00	1,600.00
Embankment..... do.....	1,200	.60	720.00	.90	1,080.00	.40	480.00
Puddling..... do.....	750	1.50	1,125.00	1.50	1,125.00	1.25	937.50
Concrete..... do.....	1,350	7.50	10,125.00	8.50	11,475.00	7.25	9,787.50
Rock face masonry..... do.....	1,430	11.00	15,730.00	12.00	17,160.00	11.50	16,445.00
Pointed face masonry, per cubic yard.....	470	13.00	6,110.00	13.50	6,345.00	17.00	7,990.00
Cut stone masonry..... do.....	90	17.50	1,575.00	18.00	1,620.00	19.00	1,710.00
Sills..... do.....	280	17.50	4,900.00	20.00	5,600.00	20.00	5,600.00
Coping..... do.....	480	17.50	8,400.00	20.00	9,600.00	20.00	9,600.00
Stone filling..... do.....	600	1.75	1,050.00	1.90	1,140.00	1.50	900.00
Riprap, hand placed..... do.....	800	2.50	2,000.00	2.60	2,080.00	5.00	4,000.00
Timber in permanent construction, per 1,000 feet, B. M.....	88,000	50.00	4,400.00	50.00	4,400.00	70.00	6,160.00
Bolt holes in masonry, per linear foot.....	4,600	30.00	1,380.00	.20	920.00	.40	1,840.00
Total.....			107,505.00		110,835.00		109,000.00

All rejected, prices being too high.

REPORT OF MR. A. M. SCOTT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W. Va., July 3, 1891.

COLONEL: I have the honor to submit the following report on the Great Kanawha River improvement for the year ending June 30, 1891.

The principal work has been on construction of Locks and Dams Nos. 7 and 8, and in maintaining and operating the five completed locks and dams. The main works under construction will be given first.

LOCK AND DAM NO. 7—CONSTRUCTION OF—

THE LOCK.

The principal work on this contract has been at excavating for foundations, placing concrete and laying masonry within the cofferdam, and at quarrying and cutting stone.

A description of the exceptional foundations of this lock was given in the last annual report, and is found on page 2240 of the Report for 1890 of the Chief of Engineers. A general description of the lock, cofferdam, etc., is given on page 1948 of the Report of the Chief of Engineers for 1889. At the close of the year ending June 30, 1890, 528 cubic yards of concrete and 104 cubic yards of masonry had been placed in the foundations.

The items of finished work done on this contract during the last year are as follows:

Concrete.....	cubic yards placed..	2, 712
Rock face masonry.....	do.....	1, 702
Pointed face masonry.....	do.....	1, 326
Bush hammered masonry.....	do.....	234
Backing masonry.....	do.....	4, 385
Sills.....	do.....	219
Quoins.....	do.....	51
Timber.....	feet B. M., placed..	33, 540
Stone filling.....	do.....	489
Paving.....	cubic yards placed..	87
Embankment.....	do.....	2, 298
Puddling.....	do.....	233
Hardpan excavation.....	do.....	1, 766
Common excavation.....	do.....	5, 496
Rock excavation.....	do.....	11

Preparing stone.—Quarrying and cutting stone for the lock was in progress the most of the time except when stopped by bad or freezing weather. During the year 2,972 cubic yards of all classes were cut, 1,462 yards of which were face or dimension stone of different classes, the remainder being squared and bedded backing. About 1,600 cubic yards of stone were broken for concrete during the year.

Present state of work.—The river wall is nearly completed to within 4½ feet (3 courses) of top of coping, being from about 24 to 28 feet above bed rock. The land wall, including the wings, is up on an average to within about 8 feet of full height. About the quoins the backing is not quite so far advanced on account of the anchorage for the gates, the placing of which is necessarily delayed until the face stone are nearly up to height.

The miter sills are both finished except the placing of the anchor bolts and wooden cushions. The guard cribs at the head and foot of lock are partly in and filled and a beginning has been made on the shore paving and riprap at the head. But little has been done on the embankment back of the land wall, and the greater part of the paving and riprap has yet to be placed.

The masonry will probably be finished by October 1, 1891, and all of the work embraced by the contract, which includes the lock complete ready for the gates, completed some time in November.

DAM NO. 7.

The contract for building the foundations and masonry of this dam was let to Munford & Reynolds, the lowest bidder, by agreement with you dated December 29, 1890, approved by the Chief of Engineers, January 12, 1891.

General description.—This, like the other movable dams on the river, is to be a Chanoine wicket dam maneuvered from a trestle service bridge. The following ex-

tracts from the specifications furnishes a brief description of the work embraced by the Munford & Reynolds contract.

The work under this contract is to consist of the foundations or immovable parts of a navigation pass and weir and of a central pier, and an abutment with shore crib and bank protection.

Navigation Pass.—The foundations for the navigation pass will be 248 feet long and about 50 feet wide. This part of the work consists mainly of a bed of concrete covered with sills, coping, paving, and timber as shown on drawings. The up and down stream faces to be light walls of rock-face masonry, covered with large bush-hammered sills and coping. The sills, coping, box-supports, timbers, etc., to be anchored, bolted, and otherwise secured as shown.

The weir.—The weir reaches from the center pier to the shore abutment, a distance of about 310 feet. (The length decided on for the weir is 316 feet.) It consists principally, as shown, of the two walls of masonry, the space between filled with concrete and puddle of selected river-bed material and the whole covered with coping, sills, and paving. The sills and coping to be anchored, bolted, etc., as indicated on drawings.

Center pier.—The center pier which separates the navigation pass and weir will be solid masonry, with rock and pointed face and bush-hammered finish, as shown generally by the drawings. It will have a circular recess for navigation pass trestle, and be covered with heavy coping as shown.

The abutment, etc.—The abutment will be of masonry, mainly of rock and pointed face. It will have bush-hammered corners and be covered with heavy coping. A trestle recess will be built in it as shown. The space between the wings will be principally filled with selected material, put in in layers and rammed. Loose stone of good size will be placed against the back part of the abutment walls, as directed by the engineer, to form a drain leading to an opening in the lower wing.

A retaining crib will be built below the abutment as indicated on drawings; it will be of squared white oak framed and drift-bolted and filled with stone. The space between the abutment wings and the top of the retaining crib will be covered with large-sized hand-placed riprap. The bank back of and above and below the abutment and crib will be graded and protected by spalls and hand-placed riprap to such extent as may be required by the engineer.

Foundations.—The character of the river bed and of the proposed foundations for the different parts of the work are shown, in general character, in the drawings and cross sections exhibited. It appears that the bed rock is covered with a considerable thickness of "hardpan" (a hard, indurated clay and cemented gravel), and this, with boulders, gravel, and finer material forming the river bed. The top of the hardpan will be generally found at a depth of from about 8 to 10 feet below low-water mark. The bed rock at the lower end of the lock where the end of the navigation pass joins it is found about 16 feet below low-water mark, but the elevation of the rock is likely to vary considerably either above or below this depth in the different parts of the dam.

It is proposed, as shown generally by the drawings, to rest part of the works directly on the bed rock, and the remainder on the hardpan.

The main part of the foundations of navigation pass and weir, the upstream walls of both, and the principal part of the pier and abutment will be built on the "hardpan" described above; the downstream walls throughout, or, as in part, the concrete under them will be carried down to bed rock, found, as stated, about 16 feet below low-water mark.

The contractors began work in January by putting a small force to work breaking stone for concrete, arranging for materials for cofferdam, etc. They decided to build a dredge for first use on this contract, and owing to delay in finishing it, and afterwards to a rise in the river beginning May 29, operations in the water were delayed over a month.

Dredging for the first section of the cofferdam, which is to inclose 150 feet of the navigation pass next to the lock, was begun June 18. The dredging on the line of this section is now about half done, and a beginning has been made on the coffer itself, the first crib being sunk June 27.

Towards preparing materials the contractors have cut 85 cubic yards of face stone and broken 1,425 cubic yards for concrete. They have also at the site 14,000 feet, B. M., of dimension oak for navigation pass.

LOCK AND DAM NO. 8—CONSTRUCTION OF—

THE LOCK.

Work on this contract has been directed mainly to laying masonry inside the coffer dam and in quarrying, transporting and cutting stone for same.

The cofferdam for the lock, as stated in the last Annual Report, was so far completed that the pumps were started June 21, 1890, and excavation inside commenced the 24th.

The first stone was set July 14, and except 16 days interruption, during the fall by high water, the laying of masonry was in progress until November 22, when operations inside the cofferdam were suspended for the winter.

The pumps were started again May 6. The water was exhausted on the 8th and the work cleaned of winter deposit, derricks raised, etc., so that the laying of masonry was resumed May 14. Between this date and June 30, 16 days were lost on masonry work by high water.

The quantities of finished work done on this contract during the year are as follows:

Rock-faced masonry.....	cubic yards, placed..	493
Pointed-face masonry.....	do.....	844
Bush-hammered masonry.....	do.....	172
Backing masonry.....	do.....	3,066
Sills.....	do.....	25
Quoins.....	do.....	43
Timber.....	feet, B. M., placed..	30,000
Stone-filling.....	cubic yards, placed..	494
Paving.....	do.....	16
Embankment.....	do.....	1,200
Puddling.....	do.....	288
Common excavation.....	do.....	5,180
Rock.....	do.....	600

Preparing stone.—The quarrying and cutting of stone for the lock was practically suspended about 2½ months during the winter; with this exception it was in progress all the time and generally with good forces. During the year 4,145 cubic yards of stone were prepared, 2,368 yards of which were face or dimension stone of different classes, the rest being squared and bedded backing. This stone was nearly all quarried at Sattes, 10 miles above Lock 8, and brought to the yard, near the site, by the Kanawha & Michigan Railroad.

Present state of work.—The land wall is built up to within 8 feet, or five courses, of top of coping, being about 14 feet from bed rock. The upper wing is up to full height at end, and puddled. The river wall has four courses complete, including foundation course, making a height of about 7 feet from rock, and considerable set on the next two courses. Nothing has been done towards setting the miter sills (they are all cut) except to partly excavate and prepare the bed rock for the foundation course under them. The guard crib at the head of the river wall and the one at the foot of the land wall are partly in and filled. But little has been done yet on the embankment and loose stone drain back of the land wall. Some paving (16 cubic yards) has been set next to the lock at the head; with this exception all of the bank protection (paving and riprap) has yet to be placed.

It is expected that this contract, which embraces the masonry, guard cribs, and bank protection complete, in short, the lock complete ready for the gates, will be finished during the present working season.

DAM NO. 8.

The contract for building the foundation and masonry of this dam, including the center pier, abutment, and shore protection complete, ready for the wickets and trestles, was made with the lowest bidder, Mr. C. I. McDonald, by agreement approved by the Chief of Engineers, March 12, 1891.

General description.—This dam, except as to character and depth of the foundations and length of weir, is to be the same as No. 7, described above. The weir will be 292 feet long; the navigation pass, like the others, 248 feet.

The foundations will be built on solid rock throughout, found on the line of dam at a depth averaging about 8 feet below low-water mark.

The sill of the navigation pass and of the weir will have the same relative references as at No. 7, the one being 13 feet and the other 8½ feet below the level of upper pool.

The contractor began building a steam dredge for use on this contract in March. Quarrying stone and breaking stone for concrete were begun in April.

Dredging for the first section of the cofferdam which incloses 150 feet of the pass next to the lock was begun May 6. The first coffer crib was sunk May 12. Operations on the river were stopped May 29 by a rise in the river, at which time the cribs for this first coffer were nearly all placed and, to a considerable extent, filled. Owing to high water the building of the cofferdam was not resumed until June 15. The rise carried a good deal of the filling out of the unfinished coffer, but none of the cribs were moved.

The cribs are now all placed; they are about two-thirds filled and some banking in. If not interrupted again by a rise this section of the coffer will be ready for the pumps about July 15.

2420 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

The contractor has cut 198 cubic yards of face and dimension stone, mostly pointed and rock face and sills, and broken 500 cubic yards for concrete. The stone comes from Sates, from the same quarries that the stone for the lock is taken. It is brought down by rail and cut in the yard, near the site.

IRONS.—ANCHORAGE, BOXES, ETC., FOR DAMS.

A contract for furnishing and delivering the irons for the anchorage and fixed parts of dams Nos. 7 and 8, including wicket and trestle boxes, hurters, slides, sills, disks, bolts, etc., for dams Nos. 7 and 8, embracing 329,108 pounds of cast iron and 88,370 pounds of wrought work, was let to the lowest bidder, the Russell Wheel and Foundry Company, of Detroit, by agreement approved by the Chief of Engineers, March 10, 1891.

The contract was completed, the irons all being delivered at the steamboat landings at the locks, in June.

LOCK NO. 2 (FIXED DAM).—OPERATING.

The lock has been in good order and regular operation. Locking was suspended 143 hours during the year by high water. The commerce through the lock during the year was as follows:

Coal	bushels..	1, 073, 000
Coke	tons ..	13, 795
Miscellaneous freight, merchandise, produce, etc., by steamboats	do....	4, 452
Lumber and logs	feet, B. M. ..	100, 050
Coal barges	number ..	243
Steamboats	do....	1, 377
Other craft	do....	140
Passengers	do....	5, 432
Number of lockages made	do....	1, 451

Ripraping.—In addition to ordinary repairs about the works about 400 cubic yards of stone were boated across the river and used to repair and strengthen the riprap and paving on the abutment side.

LOCK NO. 3 (FIXED DAM).—OPERATING.

Locking was suspended 6 days and 4 hours by high water, and 38 days and 6 hours to place the new filling valves and hang the new lower gates. The new valves and gates will be referred to below.

The principal items of commerce through the lock during the year were as follows:

Coal	bushels..	1, 637, 000
Coke	tons ..	13, 795
Miscellaneous freight, merchandise, produce, etc., by steamboats	do....	6, 521
Lumber and logs	feet, B. M. ..	814, 150
Coal barges	number..	367
Steamboats	do....	1, 485
Other craft	do....	75
Passengers	do....	8, 666
Lockages made	do....	1, 571

New filling valves.—The difficulty with the old valves is described in former annual reports of the Chief of Engineers, mainly on page 1753 of the Report for 1888, and need not be further referred to here. The new valves are like those at Lock No. 2 (except that they are one foot longer, being 6 feet long instead of 5) and are maneuvered in the same way. A general description of the No. 2 valves and of the manner of operating them is given on page 1752 of the Report of the Chief of Engineers for 1888.

The new valves were put in last August. The building of the lock chamber coffer-dam was begun August 3, and the lock was in operation again September 1.

The placing of the new valves necessitated considerable changes in and additions to the timber work in the platform and supports of the head bay. A good deal of pains was taken to make tight work all about the head bay and reduce leakage to the minimum. The anchoring of the platform and valve supports was done by long wedge bolts from the floor to the bed-rock and by wedge bolt and strap connections in masonry and bents. To make room for the ends of the valve shafts and levers the top course of projecting masonry under the gate recesses had to be removed.

The working of the valves is highly satisfactory. There is no perceptible leakage about them or any part of the head bay, and the lock is filled at full 12 feet head in 4 minutes. The valves being, as stated above, 1 foot longer than at Lock 2, some anxiety was felt about the power for opening, but there is no trouble about this;

one man with a turn and a half of the capstan easily opens a pair of the valves (making a clear opening of 25 feet) against full head in 10 seconds.

Since the new lower gates were put in, lockages are made with single emptying or filling in about 7 minutes.

New lower gates.—These are described on pages 2241–2 of the Report of the Chief of Engineers for 1890. The building of the gates was finished in July; they were raised and hung in September after the new filling valves were put in. The gates prove a fraction too long, causing some, but not material, leakage about the miter; with this exception they are a nice job of work and fitting. Besides overcoming the difficulties of the old solid gates, described in the last Annual Report, the new gates have two more valves than the old ones (five in each leaf instead of four) increasing the discharge area 25 per cent. They are also nearly 25 per cent. lighter than the old gates, each leaf weighing about 46 tons against 61 in the old ones.

The gates were built and hung and the new valves placed, including the changes in the head bay, by hired labor. The foreman of carpenters, Mr. J. S. Williams, is entitled to praise for skill and energy displayed in executing the work.

THE MOVABLE DAMS.

The three completed Chanoine dams with their locks have, with the exception of the damage to the service bridge at No. 5, described below, been in good order and regular operation during the year.

As usual a good deal was done at each of the locks in the way of repairs, principally by the regular lock hands, in keeping the works, buildings, and grounds in order. The prominent or exceptional repairs are mentioned below under that head. A brief account of operations at each of the movable dams is here given.

LOCK AND DAM NO. 4.

The dam was up 182 days in the year. The rest of the time it was kept down, owing to high or sufficient stages of water. The maneuvers of the dam and some of the principal items of commerce at No. 4 are given in the following tables:

Maneuvers of dam.	Date.	Time taken.	Men employed.	Remarks.
		<i>A. M.</i>		
Lowered	Oct. 24	6 00	5	Delayed by partial failure of tripping bar and drift.
Raised	Nov. 7 to 11	27 00	5 to 6	Delayed by bar being off guides and high water.
Lowered	Dec. 20	3 30	6	Some delay in lowering bridge caused by ice.
Raised	May 1 and 2	13 30	5	First raising. Considerable deposit on works.
Lowered	May 28	2 30	4	No difficulty.
Raised	June 29	8 30	5	Do.

	Through the lock.	Through the navigation pass.	Total.
Coal	bushels..		
Coke	tons		
Lumber and logs	feet, B. M.		
Coal barges	number..		
Steamers	do.		
Other craft	do.		
Number of lockages	do.		
	2, 530, 100	5, 126, 000	7, 662, 000
	552, 300	259, 600	13, 785
	676	1, 047	811, 900
	1, 068	1, 242	1, 723
	58	40	2, 310
			98
			1, 229

Prominent repairs at No. 4.—The hull of the service boat being worn out a new one has just been purchased for it. The derrick, cabin, etc., will be transferred to the new hull.

The difficulties experienced with the tripping bar on the lock side making it advisable to shorten it (it was cut off 32 feet in 1888 and 8 improved shunting hurters put in), twelve more of the improved hurters have been procured. They will be placed during low water this summer. This will leave fourteen wickets on that side and thirteen on the pier section to be operated by the bars.

Twenty new weir wickets—the woodwork for—were built during the winter to replace the old ones as needed.

LOCK AND DAM NO. 5.

The dam was kept up 133 days during the year. It would have been up about 50 longer but for the damage to the service bridge September 11 described below.

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The maneuvers of the dam and the most important items of commerce at the lock are given in the following tables:

Maneuvers of dam.	Date.	Time taken.	Men employed.	Remarks.
Lowered.....	Oct. 11.....	A. M.		See "repairs" below.
Raised.....	Nov. 18.....			Do.
Lowered.....	Dec. 20.....	7 00	5 to 6	Lowering hindered considerably by ice.
Raised.....	May 1 and 2.....	20 00	4 to 5	Considerable time taken to remove winter deposit, repair chains, etc.
Lowered.....	May 28.....	1 10	5	No difficulty.
Raised.....	June 27 and 28....	11 00	4 to 6	Tripping bar found off guides.

	Through the lock.	Through the navigation pass.	Totals.
Coal.....bushels.....	4, 105, 500	10, 109, 100	14, 274, 600
Coke.....tons.....			13, 795
Lumber and logs.....feet, B. M.....	930, 050	438, 700	1, 368, 750
Shingles.....number.....	751, 000		751, 000
Coal barges.....do.....	960	1, 871	2, 831
Steamboats.....do.....	1, 073	1, 711	2, 784
Other craft.....do.....	63	58	121
Number of lockages made.....			1, 259

Damage to service bridge, repairs, etc.—On the night of September 10 32 loaded coal barges broke loose in the No. 5 pool from the works of the Peel Splint Coal Company, located on opposite sides of the river about $3\frac{1}{2}$ miles above No. 5, and 8 of them were carried down and lodged against the service bridge of the dam. The rest of the barges either grounded about the heads of islands or were sunk before they reached the dam. There was a small rise in the river at the time and the coal operators in 4 and 5 pools had all been notified that evening that the dams might be lowered during the night. The river did not come up enough, however, to make it necessary to throw the dams and they were accordingly held up.

The highest point of this rise in the open river below Dam No. 6 was 6.05 feet, channel gauge, at about 8 a. m. of the 11th. On the 10th this gauge read 3.10 feet at 7 a. m. and 4 feet at 7 p. m. The highest point at Kanawha Falls was 5.80 feet at 8 p. m. of the 10th, making a change there of 3.60 feet in 13 hours. The highest point at Dam 4 occurred about midnight of the 10th, when there was 1.15 feet overflow on pass wickets, the weir wickets being all swung. This was sufficient to make considerable current in the pools (though not enough, of course, to break loose any kind of craft that was properly tied) and to bring the heavily loaded barges against the bridge with considerable force. (It will be remembered that this occurred in the night and without any notice. The barges got to No. 5 between 3 and 4 o'clock in the morning). Eight barges were lodged against the bridge. On the pass towards the pier end they were three deep, two of them sunk, one on top of the other, and the third resting on them and against the tops of the trestles. Nearer the lock the wreck of a barge was turned up on its side, the bottom tight against the bridge. Two barges were sunk on the weir, both lying lengthwise against the bridge, obstructing nearly the entire waterway between the pier and abutment. Some of the barges struck the trestles head on, but they all stopped or sunk broadside against the bridge, thus materially contracting the waterway and increasing the head and pressure of the boats against the work. There was 2 feet overflow on crest of pass wickets at highest.

The weir trestles were badly wrecked, the most of them being jammed down against the wickets (which were "on the swing") so tight that the latter could not be lowered or moved. The pass bridge was mostly intact, but could not be put down on account of the barges against it. The pass wickets were standing and had to be left up to slacken the current until the barges could be moved.

It was very important to clear the dam and get it down as soon as possible, as another rise in the river, with the sunken boats above the work, would have resulted in most serious damage to both bridge and wickets.

The Government dredge and towboat and a force of hired laborers were set to work at once tearing out the sunken boats. By the evening of the 14th the work had progressed far enough to admit of lowering the entire dam, getting it out of the way of further injury.

The damage done on the pass consisted in breaking down or badly bending 10 bridge trestles. On the weir 39 trestles were more or less injured; a number of them

were broken off at the shafts, and all of the 39 were badly bent. Several bridge rails were broken and a few of them lost.

The boxes and anchorage of the trestles were all found intact. The bridge, although so badly used, stood, all considered, remarkably well. It performed a very important service in keeping the barges from reaching the wickets, or dam proper, and the latter were entirely uninjured. If the barges had struck or gotten against the wickets, either on pass or weir, the damage would of course have been much more serious.

Many of the broken trestles had to be almost entirely rebuilt. The work was partly done in the shop at the site and partly in Charleston. It was delayed some, waiting for new channel iron, and the replacing of the trestles was hindered considerably by high water. The repairs were completed and the dam raised November 18.

The cost of the repairs and of tearing out the sunken boats, including wages of regular lock, dredge, and towboat hands while employed at it (but not including use of dredge and towboat), was about \$2,280. Outside of wages of regular hands and use of boats the affair cost the Government about \$1,450.

In reference to the breaking loose of the barges, as regards the Peel Splint Coal Company, there would seem to be no question but that it was due to insufficient fastenings. In the case of the Winifrede Coal Company it is not so clear, for the barges of the Peel Company broke loose first, came down, or swung around, and struck the Winifrede fleet, breaking their barges loose. In this connection it may be proper to add that the Winifrede Company has commenced proceedings in the circuit court of Kanawha County against the Peel Company for damages sustained by this "runaway," claiming that the latter company was negligent about tying up its barges.

A few days after the accident I had the honor to recommend to you that the Government take steps to recover from the Peel Coal Company on account of damages and expense incurred by it at No. 5.

With a system of movable dams it is very necessary to the safety and usefulness of the works that proper diligence be exercised in securing barges or any other craft that are tied up in the pools.

LOCK AND DAM NO. 6.

The dam was up 178 days during the year. The rest of the time it was down, owing to high or sufficient stages of water. The maneuvers of the dam and the commerce at this work are given in the following tables :

Maneuvers of dam.	Date.	Time taken.	Men employed.	Remarks.
		<i>h. m.</i>		
Lowered	Aug. 28	1 35	4	No trouble,
Raised	Aug. 30	6 45	4	Do.
Lowered	Oct. 6	2 05	5	Some delay by log under one pass wicket.
Raised	Oct. 11	7 00	5	No trouble.
Lowered	Oct. 24	2 00	5	Do.
Raised	Nov. 8	6 00	4 to 5	Do.
Lowered	Dec. 8	1 10	5	Do.
Raised	Dec. 14	7 20	3 to 5	Do.
Lowered	Dec. 22	2 20	4	Some delay by drift under one wicket.
Raised	May 14	12 00	4 to 5	Closing delayed by steamer <i>Budd</i> , injuring a pass trestle.
Lowered	May 28	1 30	4	No trouble.
Raised	June 17	8 00	3 to 5	Do.
Lowered	June 20	1 10	4	Do.
Raised	June 27	7 00	3 to 5	Do.

NOTE.—The reason of the frequent lowering of Dam 6 is given on page 1947 of Report of Chief of Engineers for 1889.

	Through the lock.	Through the navigation pass.	Total.
Coal	3, 948, 000	18, 344, 800	22, 292, 800
Coke .....	.....	.....	13, 795
Miscellaneous freight, merchandise, produce, etc.	13, 751	27, 899	41, 650
Lumber and logs	524, 000	5, 475, 850	5, 999, 850
Bark .....	.....	815	815
Railroad ties	30, 100	30, 000	60, 100
Staves .....	.....	220, 000	220, 000
Coal barges	1, 261	2, 731	3, 992
Steamboats	1, 098	1, 479	2, 577
Other craft	92	48	140
Passengers	6, 280	12, 578	18, 858
Number of lockages	1, 398	.....	.....

MISCELLANEOUS WORK.

Site of Lock and Dam No. 9.—The papers for the title to the land purchased for the site of Lock and Dam No. 9 were completed, approved, and recorded so that you paid for the land early in September, 1890.

Iron work for locks.—The irons for gate and anchorage, line fastenings, etc., for Locks 7 and 8, and for the new lower gates at Lock 3, contracted for with the Queen City Bridge and Steam Forging Company in March, 1890, were completed and delivered in July.

Dredging, removing obstructions, etc.—The Government dredge was in operation from July 9 to October 24. With this exception it has been laid up. The dredge and towboat with crews were at work 12 days dredging at the approaches of the finished locks, mainly at Nos. 2, 3, and 5; 24 days in tearing out the sunken coal barges at Dam 5 and in No. 5 pool, and assisting with repairs at No. 5; and 11 days at Lock 3, helping to launch, raise, and hang the new gates. The remainder of the time, until stopped by high water and laid up for the season, the dredge and towboat were employed at the head of Witcher Creek Shoal, in No. 5 pool deepening and widening the towing channel. Seven sunken coal barges were torn up, all from the "runaway" of September 11, five at Dam 5 as before described, and 2 in the channel at Witcher Creek Shoal.

The crane boat with a force of from 8 to 10 men under Capt. George Wright, pilot, worked 12 days last fall removing obstructions from the channel and public coal harbors below Charleston. The work was stopped by high water October 22. It has been continued this season by the towboat *Bee* with the crane boat when the condition of the river admitted. Altogether 135 snags and trees, 38 rocks, and a part of a wrecked barge were removed between Lock 6 and the head of Knob Shoal.

Telephone repairs.—In addition to ordinary repairs to the telephone line, 272 new poles were put up during the year.

Gauge records.—The daily gauge records and reports at Hinton and Kanawha Falls—the latter by telephone—have been kept up; also the gauge records at Charleston, Point Pleasant, and at each of the locks. New gauge cribs for bottom sections were built at Hinton and Kanawha Falls.

Office work, assistance, etc.—Aside from the engineering and drafting work required at the locks under construction, the most important items of office work were the plans, specifications, and estimates for the foundations and masonry and for the anchorage and fixed irons of Dams Nos. 7 and 8. Considerable has also been done on the design and drawings for the movable irons for these dams. One man has been at work since January on the detail drawings of Lock and Dam No. 7, ordered by the Chief of Engineers, for publication.

The organization has remained about as it was last year, and I beg leave to refer to the continued valuable services of Mr. Theodore Schoonmaker and Mr. Thomas E. Jeffries, assistant engineers, on construction of Locks 7 and 8 during the working season, and in this office on plans and drawings in the winter. Mr. C. K. McDermott, civil engineer, who rendered such efficient service on this work from 1873 to 1882, resumed connection with it last September, and has since been engaged, partly inspecting on construction, but mainly at drafting in this office. Mr. William M. Peyton has continued to attend to the accounts and clerical work and to look after the property on the improvement.

Charleston and Southside Bridge.—Under your directions to look after this wagon bridge built over the Great Kanawha at Charleston during the year, as regarded its conformity with the law and report of the board, occasional measurements of and reports on it have been made. The bridge was begun in July and finished in April. It has three through truss spans with girder, trestle, and embankment approaches. The center or channel span is 415 feet and the shore spans 144 each between centers. The channel span is 400 feet in the clear at low water, as required by law. The law requires this span to be at least 29 feet above the local highest water and at least 75 feet above low water. It is somewhat above the maximum requirements as to height everywhere (it is 7 inches above at the center), except under the first panel post at the Charleston end, where, owing to some miscalculation in levels or possible settlement of masonry, it is about three-eighths of an inch low.

This is the second bridge over the Great Kanawha the other being the railroad bridge at Point Pleasant, finished in 1888. No complaint has been made by navigators about either of these bridges and they are thought to be satisfactory both as to location and construction to all of the river interests.

Very respectfully, your obedient servant,

ADDISON M. SCOTT,
Resident Engineer.

Col. WILLIAM P. CRAIGHILL,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W. Va., July 15, 1891.

Statement showing the number of tons of coal and coke shipped from the Great Kanawha Valley, below Kanawha Falls, for the several years named.

Year ending June—	Shipments.			Year ending June—	Shipments.		
	By river.	By railroad.	Total.		By river.	By railroad.	Total.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>		<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
1881.....	385, 148	266, 266	650, 414	1887.....	929, 335	768, 436	1, 695, 771
1883.....	614, 818	531, 610	1, 146, 426	1888.....	804, 025	878, 507	1, 642, 532
1884.....	730, 843	482, 367	1, 219, 210	1889.....	1, 076, 872	881, 245	1, 958, 117
1885.....	712, 493	581, 889	1, 231, 382	1890.....	966, 462	1, 097, 337	2, 063, 799
1886.....	714, 465	558, 150	1, 272, 615	1891.....	1, 030, 454	1, 146, 721	2, 177, 175

Tonnage statement of the Great Kanawha River for the year ending June 30, 1891.

	<i>Tons.</i>		<i>Tons.</i>
Coal and coke, 25,761,346 bushels	1, 030, 454	Hoop poles, 1,280,000	1, 920
Timber, 23,300,000 feet, B. M.	38, 833	Merchandise and produce by steamboats.	64, 000
Oak staves, 762,500	2, 288		
Tan bark, 265 cords	290	Total tonnage	1, 225, 355
Railroad ties, 625,500	87, 570		

Respectfully submitted.

ADDISON M. SCOTT,
Resident Engineer.

Col. WILLIAM P. CRAIGHILL,
Corps of Engineers, U. S. A.

II 2.

OPERATING AND CARE OF LOCKS AND DAMS ON GREAT KANAWHA RIVER, WEST VIRGINIA.

During the fiscal year the expense of operating the locks and dams on the Great Kanawha River, in West Virginia, has been paid in the manner indicated by section 4, act of July 5, 1884.

In compliance with the proviso to that section, which requires the rendition of an itemized statement of such expenses, I have the honor to forward the inclosed paper.

Statement of amount expended during the fiscal year ending June 30, 1891, out of the general appropriation for "operating and care of canals and other works of navigation," in operating and keeping in repair the locks and dams on the Great Kanawha River, West Virginia.

Lock and Dam No. 2:

For wages of regular lock hands	\$2, 174. 25
For repairs and extra labor	268. 37
For supplies, as paints, oils, fuel, tools, etc.	138. 35
For freights and transportation	6. 83
	<u>2, 587. 80</u>

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Lock and Dam No. 3:

For wages of regular lock hands	\$2,280.00
For repairs and extra labor	2,477.48
For supplies, as paints, oils, fuel, tools, etc	147.47
For freights and transportation	23.26
	<u>4,928.21</u>

Lock and Dam No. 4:

For wages of regular lock hands	2,280.00
For repairs and extra labor	799.86
For supplies, as paints, oils, fuel, tools, etc	129.11
For freights and transportation	11.13
	<u>3,220.10</u>

Lock and Dam No. 5:

For wages of regular lock hands	2,135.92
For repair and extra labor	2,056.08
For supplies, as paints, oils, fuel, tools, etc	172.75
For freights and transportation	22.38
	<u>4,387.13</u>

Lock and Dam No. 6:

For wages of regular lock hands	2,245.25
For repairs and extra labor	330.95
For supplies, as paints, oils, fuel, tools, etc	162.13
For freights and transportation	5.61
	<u>2,743.94</u>

Superintendence and central office expenses:

Wages	3,424.09
Rent and supplies	281.96
Freights and transportation	26.89
	<u>3,732.94</u>

Dredging at locks and part of running expenses of steamboat:

Wages	1,381.57
Repairs and supplies	50.08
Freights and transportation	2.42
	<u>1,434.07</u>

Telephone line:

For rent of instruments	140.00
For repairs and supplies	338.79
For freights and transportation	17.26
	<u>496.05</u>

Gauge reports:

For pay of gauge keepers and reporters at Hinton and Kanawha Falls	143.28
For repairs and supplies	161.70
For freights and transportation .....	.35
	<u>305.33</u>

Total 23,835.57

II 3.

IMPROVEMENT OF ELK RIVER, WEST VIRGINIA.

Nothing was done during the year ending June 30, 1890. A small force was employed from the 16th to 23d of October, 1890, in removing snags and logs from the channel and cutting leaning trees from the banks between Morris Creek and Blue Creek Island. Morris Creek is 22½ miles from Charleston and Blue Creek 13½. Fifteen snags and logs were taken out and 14 trees cut down, and an old boiler was removed from the channel at the foot of Blue Creek Shoal. Operations were suspended by a rise in the river October 23, 1890, and could not be resumed in 1890 or in 1891 until May 19.

The project approved for the expenditure of the last appropriation of \$2,500, September 19, 1890, for this river, including the small balance left over of the old appropriation, contemplated the completion of the blasting work in Webster County, below Addison, stopped at Painter Lick Shoal in November, 1888 (Report of Chief of Engineers for 1889, page 1956, etc.), and some work between Sutton and the mouth of the river in repairing, strengthening, and altering chute walls and removing obstructions.

The only work done during the year was in removing obstructions in the interest of push boat and steamboat navigation in the lower part of the river, the principal part of the project being advisedly postponed until low water during the summer and fall; it will probably be commenced early in August, 1891.

At removing obstructions in the lower river something was done in September and October, 1890, but the work was stopped for the season, October 22, by high water. It was resumed May 19, 1891, and has been under way since, with a small force of hired laborers, when the condition of the river would admit. The principal items of work done, including what was accomplished last fall, consisted in taking out 153 snags, stumps, logs, etc., 18 large rock, and cutting a number of leaning trees.

The work was done between the foot of Queen Shoal and Jarrett Ford. The former is 25 miles and the latter 12 miles from the mouth of the river. This work is still in progress.

The law of September 19, 1890, called for an examination of the river with a view to improving the same by locks and dams. A report on the subject was submitted December 13, 1890.*

Money statement.

July 1, 1890, balance unexpended.....	\$574. 89
Amount appropriate by act approved September 19, 1890.....	2, 500. 00
	<hr/>
June 30, 1891, amount expended during fiscal year.....	3, 074. 89
	320. 58
	<hr/>
July 1, 1891, balance unexpended.....	2, 754. 31
July 1, 1891, outstanding liabilities.....	1, 000. 00
	<hr/>
July 1, 1891, balance available	1, 754. 31
	<hr/>
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	2, 500. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

* See Appendix II 6.

Commercial statistics for Elk River, West Virginia.

Year ending June—	Saw logs and lumber.	Railroad ties.	Oak staves.	Hoop poles.	Hickory spokes.	Oak tan bark.	Tonnage of timber products.
	<i>Feet B. M.</i>					<i>Cords.</i>	<i>Tons.</i>
1883	5,200,000	100,000	898,334	.....	.....	.....	24,790
1884	5,975,000	125,000	1,222,500	.....	.....	.....	30,700
1885	5,100,000	250,000	1,433,750	.....	.....	.....	33,500
1886	15,361,000	250,000	1,845,000	.....	.....	.....	68,510
1888	15,900,000	330,000	1,210,000	.....	.....	.....	71,150
1889	15,750,000	295,000	1,600,000	500,000	350,000	.....	70,200
1890	26,650,000	330,000	1,380,000	150,000	563,000	300	89,880
1891	27,995,000	412,500	800,000	125,000	200,000	500	103,700

The amount of general merchandise and produce carried on the river during the last year is estimated at 11,000 tons, making the total, with the timber products as above, 114,700 tons.

II 4.

IMPROVEMENT OF GAULEY RIVER, WEST VIRGINIA.

During the fiscal year ending June 30, 1890, nothing was done upon this river, the number and height of the freshets having made it uneconomical to organize a force for the expenditure of the small available balance, as so much time would have been lost and but small results could have been shown.

Operations were resumed in July, 1890, in the belief that funds would be supplied in that month by a new appropriation, but the appropriation of \$3,000 was not made until after the middle of September. Meantime work was necessarily suspended the last of August for want of money and it was too late after the appropriation was available to commence again in 1890.

Some preparations were made toward the end of May, 1891, for the resumption of operations on the river, but high water has almost entirely prevented work in June. A little has been done toward the close of the month at the head of Big Creek, Pool, and Winding shoals in rearranging some of the regulating walls of loose rock. These shoals are respectively $1\frac{3}{4}$, 2, and $2\frac{1}{2}$ miles from the mouth of the river.

Money statement.

July 1, 1890, balance unexpended	\$1,684.58
Amount appropriated by act approved September 19, 1890	3,000.00
	<hr/>
June 30, 1891, amount expended during fiscal year	4,684.58
	1,745.62
July 1, 1891, balance unexpended	2,938.96
July 1, 1891, outstanding liabilities	600.00
	<hr/>
July 1, 1891, balance available	2,338.96
	<hr/>
{ Amount (estimated) required for completion of existing project	4,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	4,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. WM. PROCTOR SMITH, ASSISTANT ENGINEER.

GAULEY BRIDGE, W. VA., *September 22, 1890.*

COLONEL: I have the honor to submit the following report of operations on the improvement of Gauley River, West Virginia, for the season of 1890.

From the 23d of June to 2d of July the time was devoted to getting tools, boats, and men in readiness to begin actual work in the river. Gauges were made and established at several points with their zero at ordinary low water.

Laborers could not be obtained until the 7th of July, although the river was clear and low for the week previous. On that date, however, the work was begun at the mouth of the river and continued without intermission until the 31st of August, at which time work was suspended temporarily for lack of funds, and this suspension continues to the date of this report. The intervening time was used by the assistant engineer in measuring up the work for the season and making sketches of the various points at which obstructions were encountered, and getting together data for and in writing this report.

A channel from 20 feet to 40 feet wide and 2 feet deep at ordinary low water was made through three solid sandstone ledges and 12 shoals of loose rock, from the mouth of the river to Rich Creek, a distance of 8 miles, to a pool $1\frac{1}{2}$ miles in length.

In this distance occur one shoal, Foster's, $6\frac{1}{2}$ miles above the mouth of the Gauley, and two small shoals immediately above that were not improved for the reason that the lumber and boatmen wished Mill Shoal, a very bad one, cleared out, and they, if no more money should become available this season, could manage to make a small channel through the three shoals mentioned that would answer the purpose until the work could be properly done.

The small rises in July and August carried some of the loose stone to the foot of three of the shoals below Twenty-Mile Creek and there deposited them, lessening the depth somewhat, but not sufficient to impede the passage of the boats. It was thought that high water would remove these obstructions, but two subsequent rises of 5 feet and 6 feet failed to do it, so the work will have to be done by manual labor. To do this, finish up the three shoals, and trim up the work generally will cost about \$150. In connection with this subject it may be said that the gauges are placed in the pools reading zero at ordinary low water; when these gauges read, say, 10 inches below zero, the water in the chutes in the shoals does not stand at that height, but 2 or 3 inches lower; it seems to slip away to the pools and sides of the river at the shoals.

At these low stages of the river the boats only carry one-half loads.

From the circumstances mentioned above it is thought it would be difficult work to make a channel 2 feet deep at extreme low water, for it would drain the pools and a sluice would have to be made the entire length of the river.

At Scrabble Creek and Buck Ford, which were worked at in the fall of 1888, when the water continued so high it was difficult to locate the work properly, it was found necessary to make some changes which involved more work than was anticipated, owing to which the project could not be completed with the funds available.

The combined width of ledges and shoals worked through amounts to 6,368 feet. To do this work the following materials were used and labor performed:

The total amount of stone removed was 2,282 cubic yards—212 cubic yards of this were solid rock, and 2,070 cubic yards loose rock. This stone was built into side and wing walls the aggregate length of which amounts to 9,144 feet, varying in width from 11 feet to 3 feet, and in height from 5 feet to $\frac{1}{2}$ foot. The cost per cubic yard of solid rock was \$2, and of loose rock 50 cents, measured in the walls.

There were 204 holes drilled and the same number of shots fired. The drilling amounted to 446 feet.

The average work of a set of three men per day of 8 hours was 15 feet of drilling.

Two hundred and eighty-four cartridges of Ajax and Criterion powder, containing 40 per cent. nitroglycerin, were used, and 900 feet of double-taped fuse.

One and four-tenths cubic yards of solid rock were loosened per blast. There were 672 days' work of 8 hours at \$1.20 per day. Nine days were lost out of a possible 48. The average number of men per day was 144. Highest number 24, lowest number 7.

Four small rises occurred averaging 2.7 feet, and one of 5.3 feet. September 10, after work was stopped, the river rose 6 feet in $4\frac{1}{2}$ hours. The highest gauge reading was 4.5 feet above and the lowest 1 foot below zero.

It rained more or less 17 days from 7th July to 31st of August.

For names of shoals, their distances from the mouth of the river, and the quantity and quality of material removed, reference is made to the table accompanying this report.

One rock boat and two canoes were hired and tools bought to replace those returned to the Great Kanawha River Improvement:

The property is stored with J. H. Miller, jr., at Gauley Bridge. Three bateaux and three flatboats, drawing about 16 inches with their average load of 9,000 feet of lumber, are now in use on the river, and three more will be put on soon.

There are 8 sawmills, averaging 12,000 feet per day and one stavemill on the tributaries of the Gauley within the limits of the work this season. The lumber being shipped is ash, poplar, walnut, and oak.

The boatmen and lumbermen seem to be well satisfied with the work, except that they fear some difficulty in Mill Shoal as the channel is crooked. It would have been better to have a straight channel here, but time and means did not permit. A boat loaded with lumber passed through this chute last week without trouble, which shows the channel to be much improved, for this could not have been done before the shoal was worked at.

An examination was made of Little and Big Roughs, respectively 12 and 13 miles from the mouth of the river, with a view to improving them for the purpose of floating logs, and it is thought that the work will not be difficult.

There is a boom in the Gauley River section at present and large tracts of coal, farming, and timber lands have been sold at enhanced prices.

Respectfully submitted.

WM. PROCTOR SMITH,
Assistant Engineer.

Col. WM. P. CRAIGHILL,
Engineer Corps, U. S. A.

Table.

Name of shoal or ledge.	Distance from the mouth of Gauley.	Width of ledges and shoals.	Solid rock.		Total.
	Miles.	Feet.	Cu. yds.	Loose rock. Cu. yds.	
Junction of Gauley and New Rivers	0	200	30		30
Scrabble Creek Ledge	1	330	53		53
Bucks Ford Ledge	1	339	116	96	212
Big Creek Shoal	1½	846	2	62	64
Pool Shoal	2	283		32	32
Winding Shoal	2½	400		166	166
Kineaid Shoal	2½	525		53	53
Durden Shoal	2½	460	2	161	163
Durden Ripple	3	168		6	6
Long Shoal	3½	776		207	207
Twenty-Mile Shoal	5	1,464		421	421
No. 1, above Twenty-Mile	5½	205	2	138	140
No. 2, above Twenty-Mile	6	143		61	61
No. 3, above Twenty-Mile	6½	100		20	20
Mill Shoal	7½	1,075	7	647	654
Total		7,314	212	2,070	2,282

Commercial statistics for Gauley River, West Virginia.

Year ending June 30—	Sawlogs.	Lumber.	Staves.	Tonnage of timber.	Produce, etc.	Total from Gauley.	Merchan- dise to Gauley.
	Feet.	Feet.			Tons.	Tons.	Tons.
1888	601,800	2,535,300	177,400	7,121	36	7,151	750
1889	890,400	3,615,000	274,200	9,491	78	9,569	1,322
1890	384,800	4,452,500		9,676	90	9,766	1,985
1891	381,700	4,701,300	100,000	10,347	89	10,436	1,964

This commerce is carried on with four bateaux and four flatboats, drawing about 18 inches of water, and of 18 tons capacity each.

III.

IMPROVEMENT OF NEW RIVER, VIRGINIA AND WEST VIRGINIA.

After a suspension of the operations for some years for want of funds an appropriation of \$10,000 was made August 6, 1886, applicable, however, only to the portion of the river above the Lead Mines in Wythe County, Va.

Doubt having arisen, in view of the changed condition of affairs on and near the river, as to the propriety of expending this appropriation at once, it was decided by proper authority to defer operations until the will of Congress could be further ascertained.

In the river and harbor act of August 11, 1888, it was directed that the balance should be spent in improving the river between Ivanhoe Furnace, in Wythe County, and the mouth of Wilson Creek. Operations in accordance with this direction were commenced in June, 1889, and continued until October 10, 1889. The work done was in the neighborhood of Ivanhoe Furnace, and was continued until necessarily suspended by high water. A balance of \$2,341.79 was left, which still remains.

The expenditures on this river up to 1886 were highly useful, but since that time the situation has changed. In a report of April 17, 1891, given below, it was recommended that the remaining balance be not spent at present. To this the Secretary of War agreed.

Money statement.

July 1, 1890, balance unexpended	\$2,341.79
July 1, 1891, balance unexpended	2,341.70
<hr/>	
{ Amount (estimated) required for completion of existing project	159,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF COLONEL WM. P. CRAIGHILL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Baltimore Md., April 17, 1891.

GENERAL: A balance of \$2,341.79 remains of the last appropriation for New River, Virginia and West Virginia, of \$10,000, August, 1886. For reasons which will appear below it is believed the expenditure of this balance would be a waste of money.

The law of June 10, 1872, called for a survey of the river from the mouth of the Greenbrier at Hinton, W. Va., to the Lead Mines in Wythe County, Va. A full report, with maps, was submitted in a short time thereafter, which may be found in the Annual Report for 1873, pages 842-854. This included 128 miles of the river.

Three plans of improvement were estimated for, viz: 1st, a 2-feet bateaux navigation, to cost \$100,000; 2d, a 3-feet steamboat navigation without locks, to cost \$1,000,000; 3d, a system of locks and dams for a navigation of 5½ feet, to cost \$2,500,000.

The first appropriation was made in 1876, \$15,000; work was commenced in 1877 and continued several years on the section of the river indicated, with good results for a fine country bordering the stream, but up to that time much undeveloped. The railroads of the country at that time were the Norfolk and Western, which crossed the river in Pulaski County, in the southwest part of Virginia; and the Chesapeake and Ohio, which touched it at the mouth of the Greenbrier, at Hinton, in West Virginia, and then ran along its banks to its junction with the Gauley, where the two form the Great Kanawha.

The law of June 18, 1878, called for a survey of the upper portion of the river, 62 miles in length, from the Lead Mines in Wythe County to the mouth of Wilson Creek in Grayson County, Va., near the border of North Carolina. The report in full may be found in the Annual Re-

port for 1879, Part I, pages 538-545. Three estimates were presented for this part of the river also, which has but one-half the length of the lower portion already referred to. These estimates were as follows, viz: 1st, for a 2-foot bateaux navigation, to cost \$115,000; 2d, for a 3-foot steam navigation, \$1,200,000; 3d, a 5-foot steam navigation, \$1,600,000, with locks and dams.

The plan of improvement adopted for the whole river was that which would cost the least, \$215,000, and called for a navigation of 2 feet at low water. There were appropriations in 1880, 1881, and 1882. Meantime the usefulness of the river became less and less as a means of transportation, due much to the great development of the railroad systems, in some parts paralleling the river; and because of the great cost of the improvement, especially in the upper portions, was greatly out of proportion to the advantages under the changed conditions.

Here attention may be called to the effect of the changing conditions which sometimes arise, and New River is a striking illustration of it. In a country rich in minerals and agricultural products, a natural waterway may be of the greatest value, especially if there be no competing railroads, and the cost of its improvement be not very great. In course of time competing railroads are built, the topography being favorable. If the expense of the improvement of the river be great and the available money little, the railroads will take the business and the river becomes comparatively unimportant. This has for some years been the situation in the New River country, especially the upper portion.

In time, as population increases and great mining, manufacturing, and agricultural interests become enlarged, the importance of the natural water way again increases to such an extent as to justify a higher style of improvement, and in many instances the construction of canals is also found advantageous. This condition has been reached in several of the great European States, and will be in time in the United States.

New River has, however, not reached this stage. It is at present in the second stage of comparative unimportance.

This condition seems to have been recognized by Congress, as may be inferred from the fact that there were no appropriations for New River in 1883, 1884, and 1885. July 1, 1886, there was a balance remaining unexpended of \$3,000 from the appropriation of August 2, 1882. This pertained by special designation of the law to the portion of the river above Foster Falls, which were not passable. The balance remained unexpended because of the impassability of these falls. As the disconnection with routes of transportation caused by these falls would practically disappear on the completion of the railroad then being constructed up Cripple Creek, and as boats could then ship to the railroad their freight at Porter Ferry above the lead mines and the falls, it was concluded to improve the condition of Williamson Ledges and Shoals for temporary uses. This work was continued as late as the season allowed, a small balance of funds being left unexpended, but not large enough to justify the resumption of operations in the summer of 1886.

There was an appropriation of \$10,000 in the law of August 5, 1886, *applicable only to the portion of the river above the lead mines*, the most expensive portion. When the money became available it was too late to commence operations in 1886. For more than one reason it seemed inexpedient to expend this appropriation in the year ending June 30, 1888. The portion of the river to which it was applicable is above Foster Falls, and these can only be passed by one or two locks for the construction of which the money available was altogether inadequate. There was also strong reason for doubt whether, considering the pres-

ent development of that section of the country, the construction of such locks would be justifiable, even if the money were available. The construction of railroads near this stream had diminished very much the importance of the improvement of the portion above Foster Falls. After a careful reëxamination of the subject and a reconnoissance of the river and its vicinity, it was decided by the Secretary of War to postpone the expenditure of the appropriation until the will of Congress could be further ascertained.

In the river and harbor act of August 11, 1888, it was, however, directed that the balance should be spent in improving the river between Ivanhoe Furnace, in Wythe County, and the mouth of Wilson Creek, the most expensive part of the work. Operations in accordance with this specific direction were therefore commenced June 9, 1889, and continued until October 10, 1889.

In 1885 there was a channel 2 feet deep and 20 feet wide from Ivanhoe Furnace to within 600 feet of the head of Wilkinson Shoals and Ledges, a distance of 3.9 miles.

In 1889 this channel, with the same width and depth, was extended to the lower end of the approach to the Gulf, a distance of 5 miles from the initial point, with four-tenths of a mile further up the river partially improved. This is obviously a very local improvement, made almost entirely in rock at great expense and, in my opinion, of no value whatever. No work was done in the calendar year 1890, and none has been possible as yet in 1891, the water being too high and too cold.

* * * * *

No appropriation has been made since 1886.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

III.

PRELIMINARY EXAMINATION OF ELK RIVER, WEST VIRGINIA, WITH A VIEW OF IMPROVING THE SAME BY LOCKS AND DAMS.

[Printed in House Ex. Doc. No. 103, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 16, 1890.

SIR: I have the honor to submit herewith report dated December 13, 1890, from Col. Wm. P. Craighill, Corps of Engineers, giving results of preliminary examination of Elk River, West Virginia, with a view of improving the same by locks and dams, made to comply with requirements of the river and harbor act approved September 19, 1890.

Colonel Craighill reports that in his opinion the improvement of Elk River by locks and dams is not worthy of being undertaken by the United States.

I concur in his views.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF COLONEL WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., December 13, 1890.

GENERAL: In compliance with your instructions of September 20, 1890, I have the honor to submit below a report as to the examination of "Elk River, West Virginia, with a view of improving the same by locks and dams."

A survey of this river was made in 1875, a report of which may be found in the Annual Report of the Chief of Engineers for 1876, Part II, pages 166-176. Estimates were given for two methods of improvement. One of these consisted in the removal of snags, rocks, overhanging trees, etc., and the cutting of narrow sluices through the rapids and shoals, the chief interests to be subserved being those of lumbering and rafting, as also the movement in smaller boats of much country produce with a return of merchandise. This project was estimated to cost \$100,000. Under this project the first appropriation was made of \$5,000, June 18, 1878, and the last of \$2,500 by the river and harbor act of September 19, 1890. The amount expended up to this date has been \$21,048.40, with great advantage to the navigation of the river and to the manifest benefit of the country through which it flows. This method of improvement should be continued. Its progress has been detailed annually in the Reports of the Chief of Engineers.

The second method of improvement estimated for in the report of 1875 was for locks and dams. The amount was \$1,500,000. This has not been entered upon, and in my judgment the present and prospective needs of commerce do not warrant it. Should, however, Congress, decide otherwise, it should be with the knowledge that the coal trade now requires larger locks than were deemed necessary 15 years ago, and the estimate for an improvement by locks and dams must be increased to \$2,800,000 if carried to Sutton, 100 miles from the mouth of the river, or \$1,900,000 if carried to a point a little above Big Otter Creek, about 67 miles from the mouth of the river.

For the facts and reasons set forth herein and the accompanying copy of report of December 1, 1890, from Mr. A. M. Scott, and having in view the present and prospective needs of commerce, I have to state, as required by the river and harbor act of September 19, 1890, that in my opinion the improvement of Elk River, West Virginia, by locks and dams is not such a one as to be worthy of being undertaken by the United States.

No further survey is necessary.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. A. M. SCOTT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W. Va., December 1, 1890.

COLONEL: In reply to yours of September 30, I have the honor to submit the following in reference to a report required by the last river and harbor law on Elk River, "with a view of improving the same by locks and dams."

The examination of Elk River, made in 1875 under your direction by Mr. N. H.

Hutton, C. E., and the full reports on the same (published in the Annual Report of the Chief of Engineers for 1876, Part II, pages 166 to 176), seemed to make further preliminary surveys unnecessary at this time.

As regards the natural resources and general characteristics of the valley, the reports referred to and the letters and extracts from other reports published with them make a pretty full showing of this part of the subject. A considerable additional amount of information under this head is found in Maury and Fontaine's Resources of West Virginia. (See pages 197, 258, 259, 367, 368, 371, etc., published in 1876 for the State board of centennial managers.)

For further and more exact information on the coal development of the valley I inclose copies* of private geological reports made by Prof. E. B. Andrews, of the geological survey of Ohio, and Prof. M. F. Maury, on a large tract of land situated on Elk River, mainly in Clay County. These last named reports were kindly loaned this office by Maj. Albert H. Campbell, of this place. They embrace about 30 miles of the south side of the river between points about 40 and 70 miles from the mouth.

There can be no doubt about the extent and fine quality of the coal on a very considerable part of Elk River. So far as at present determined: the best development of working seams above water level embraces about 50 miles of the river, beginning near Big Sandy, about 22 miles from the mouth of the river, and extending to the neighborhood of the line between Clay and Braxton counties. Professor Maury, in Maury and Fontaine's Resources of West Virginia, takes the mouth of Big Otter Creek, in Clay County, as the approximate eastern point on the western line for the lower coal measures to sink below water level. It will be noticed that both he and Professor Andrews, in their reports, describe good seams above the river on O'Brien Run, 7 miles above Big Otter. This point, 72 miles from the mouth of the Elk, is probably nearer the eastern limit of the good workable seams on or near the river than are above water level.

The character and extent of the existing navigation and commerce are fully presented in your recent annual reports to the Chief of Engineers down to that for the year ending June 30, 1890.

Whether the river is "worthy of improvement" by locks and dams or not seems to depend mainly on the importance to be attached to the demand for transportation of the coal. Aside from this the "present and prospective demands of commerce," though no doubt of considerable importance, would hardly seem to justify the large expenditure required to build and maintain a system of locks and dams.

In considering the present and future demands of commerce "and what public necessity or convenience may be subserved" by a slack-water improvement, the strong probability, not to say certainty, of one of the several projected railroads being built along the river before many years should be taken into account. While it is true that a railroad will, in many ways, supply the present and growing demands of commerce and for communication in and through Elk Valley, it is evident it can not do this to the best advantage for coal.

A brief representation of the cost of carrying coal by river may be of interest in this place. The present cost of taking coal from the Charleston pool to Cincinnati is about 1.4 mills, or one-seventh of a cent, per ton per mile. This is for operators who hire everything, both barges and towing, and covers the total expenses to such for the coal delivered at Cincinnati; it also covers the return of the empty barge. The cost to operators who own their own barges and towboats, as some of the large operators on the Great Kanawha do, is probably not more than 1 mill per ton per mile. These rates are to Cincinnati, a distance of 263 miles from Charleston. For longer distances, i. e., for points on the Ohio and Mississippi below Cincinnati, the rates per mile are less than this.

The cost of towing coal on Elk River from the mines to the Charleston pool with a slack-water improvement (supposing no tolls charged) may safely be taken at a mill and a-half per ton per mile. It would probably be less than this. Taking it at that, the cost of towing from the mouth of Big Otter would be a little less than 10 cents per ton or \$48 per barge of 480 tons. This, added to the present rate from the Charleston pool for operators who hire both barges and towing, would make, including the return of barges, a total cost of about 48 cents per ton from Otter Creek to Cincinnati, a distance by river of 328 miles.

Mr. Hutton, in his report of 1875, estimated for a depth of 4 feet on the lock sills, with locks 120 feet length and 24 feet breadth. This depth of navigation and size of locks would be insufficient for a coal business, the first requirement for which is that the coal shall go to market without breaking bulk, in regular-sized, full draft (6 feet) barges. The smallest lock that would answer for single barges would be 26 feet wide and about 148 feet between quoins. For the following estimate the locks were planned 27 feet wide and 155 feet between quoins, with a minimum depth of 6½ feet on miter sills, the locks of masonry, the walls throughout carried up 8 feet above crests of dam. The lifts were taken at 12 feet. The average depth of foundations

* Not printed.

for locks, dams, and abutments was taken 5 feet below low-water mark and all considered as resting on solid rock.

The dams to be mainly of round logs flattened at crossings and filled with stone; tops to be covered with square timber and planked; backs to be sheathed and banked. The abutments to be of masonry, with coping 8 feet above crest of dam. Retaining cribs and shore protection on both sides are also included.

In reference to water supply for this sized lock—taking the minimum as low as estimated by Mr. Hutton, 80 cubic feet per second, which at most can be but for a small part of the year—it would be sufficient for three lockages per hour after making liberal allowances for waste, etc. Two loaded coal barges per hour would amount to 23,040 tons (576,000 bushels) per day.

The estimate is as follows:

For one lock:

Grubbing and clearing.....	\$200
8,000 cubic yards of earthwork excavation and embankment, at 55 cents.....	4,400
800 cubic yards rock excavation, at \$2.....	1,600
200 cubic yards puddling, at \$1.....	200
530 cubic yards cut stone masonry, sills, quoins, and coping, at \$16..	8,480
1,750 cubic yards pointed face and rock face masonry, at \$10.....	17,500
3,000 cubic yards backing masonry, at \$6.50.....	19,500
100 cubic yards concrete, at \$6.....	600
3,000 cubic yards riprap and stone filling, at \$1.50.....	4,500
400 cubic yards paving, at \$3.....	1,200
60,000 feet, B. M., of timber, at \$30.....	1,800
16,000 linear feet of crib logs in cofferdam, at 15 cents.....	2,400
10,000 feet, B. M., of sheathing in cofferdam, at \$20.....	200
1,600 cubic yards of filling in cofferdam, at 50 cents.....	800
For lock gates and iron work in lock.....	4,500
For land at site and lock-men's houses.....	3,500

71,380

For contingencies, inspection, engineering, etc., say..... 14,620

Total for one lock, including site and buildings..... 86,000

For dam and abutment:

Grubbing and clearing.....	200
5,000 cubic yards excavation, at 60 cents.....	3,000
8,500 cubic yards backing and embankment, at 50 cents.....	4,250
200 cubic yards puddling, at \$1.....	200
450 cubic yards masonry, at \$9.....	4,050
20 cubic yards coping, at \$16.....	320
7,000 cubic yards stone filling and riprap, at \$1.50.....	10,500
26,000 linear feet of round timber, at 20 cents.....	5,200
85,000 feet, B. M., of square timber and plank, at \$30.....	2,550
1,600 pounds spikes and bolts, at 5 cents.....	800

31,070

For contingencies, inspection, engineering, etc., say..... 5,930

Total for dam and abutment..... 37,000

Total for lock..... 86,000

Total for lock and dam..... 123,000

For dredging in pools, deepening and widening channels at shoals, average per pool, say..... 4,000

127,000

For 22 locks and dams, carrying the improvement to Sutton, 100 miles from the mouth..... 2,794,000

For 15 locks and dams, carrying the improvement to Walter's Defeat Shoal, 1½ miles above Big Otter and 67 miles from the mouth of the river..... 1,905,000

Very respectfully, your obedient servant,

ADDISON M. SCOTT,
Resident Engineer.

Col. WM. P. CRAIGHILL,
Corps of Engineers, U. S. A.

APPENDIX J J.

IMPROVEMENT OF CERTAIN RIVERS IN KENTUCKY AND WEST VIRGINIA.

REPORT OF MAJOR D. W. LOCKWOOD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|---|---|
| 1. Tradewater River, Kentucky. | 7. Big Sandy River, West Virginia and Kentucky. |
| 2. Operating and keeping in repair locks and dams on Green and Barren rivers, Kentucky. | 8. Levisa Fork of Big Sandy River, Kentucky. |
| 3. Rough River, Kentucky. | 9. Tug Fork of Big Sandy River, West Virginia and Kentucky. |
| 4. Kentucky River, Kentucky. | 10. Guyandotte River, West Virginia. |
| 5. Operating and keeping in repair locks and dams on Kentucky River, Kentucky. | 11. Little Kanawha River, West Virginia. |
| 6. Licking River, Kentucky, from Farmers to West Liberty. | 12. Buckhannon River, West Virginia. |

EXAMINATIONS.

- | | |
|--|---|
| 13. Big Barren River, Kentucky, above Bowling Green, with a view of extending slack-water navigation by additional locks and dams. | 15. Green River, Kentucky, above the mouth of Big Barren River, with a view of extending slack-water navigation on Green River. |
| 14. Russel's Fork of the Big Sandy River, Kentucky, with the view of removing obstructions from the same. | |

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, July 11, 1891.

GENERAL: I have the honor to transmit herewith the annual reports on the works under my charge at the close of the fiscal year ending June 30, 1891.

First Lieut. Wm. L. Sibert, Corps of Engineers, has been on duty under the direction of this office throughout the year.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

J J I.

IMPROVEMENT OF TRADEWATER RIVER, KENTUCKY.

The Tradewater is a tributary of the Ohio and empties into it 79 miles below Evansville, Ind.

The project for the improvement, adopted in 1881, contemplated originally the removal of obstructions, such as bars, snags, etc., so as to open up to navigation 22 miles of the river by forming a channel with a minimum width of 40 feet and a minimum depth of 2½ feet for 8 months. The survey upon which the project was based covered 41 miles of river, and the scope of the work has been extended to embrace this although the depth of water, 2½ feet, can only be secured for about 5 months each year in the upper portion.

During the past fiscal year the river has been thoroughly gone over from its mouth to Bellville, a distance of 41.15 miles, and such obstructions as had escaped observation in the previous year or had reformed or originated after the closing of work in the season before were removed. Work commenced shortly after August 1, 1890, and closed December 23. During that time the ruins of a stone dam 68 feet long, 4 feet broad, and 3½ feet high were removed from the river at Nunn Ripple. In addition to this, 669 snags, 17 trees, 511 logs that were obstructions to navigation were removed; 2,551 stumps were grubbed and 279 tree tops cut up.

Money statement.

July 1, 1890, balance unexpended	\$2, 856. 19
June 30, 1891, amount expended during fiscal year	1, 837. 65
July 1, 1891, balance unexpended	1, 018. 54

COMMERCIAL STATISTICS FOR THE FISCAL YEAR ENDING JUNE 30, 1891, TRADEWATER RIVER, KENTUCKY.

Articles.	1889.	1890.	1891.	Articles.	1889.	1890.	1891.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>		<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Coal.....	29, 995	28, 975	19, 000	Railroad ties.....		7, 457	18, 750
Corn.....	1, 741	3, 192	1, 350	Staves.....	113	900	2, 012
Flour.....	1, 740			Tobacco.....	89	283	
Hoop poles.....	28	304		Wheat.....	6, 430	4, 410	1, 850
Live stock.....	605			Merchandise.....	250	713	
Lumber, sawed.....	5, 710		4, 977	Total.....	50, 274	46, 401	54, 239
Logs.....	3, 040		6, 300				
Produce.....	533						

List of boats plying on Tradewater River, Kentucky.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	
E. J. Ragon.....	Passenger.....	165	31	5. 6	65
J. C. Kerr.....	do.....	135	25	5	55
Little Mary.....	Passenger and tow.....	105	27	3. 6	43
Maggie Bell.....	do.....	115	20	3. 6	50
D. A. Brooks, Jr.....	do.....	70	18	3. 6	50
John A. Logan.....	do.....	90	20	4	70
Mollie Snyder.....	Tow.....	40	12	4	4
Swan.....	Pleasure.....	22	6	8. 5	2

J J 2.

OPERATING AND KEEPING IN REPAIR LOCKS AND DAMS ON GREEN AND BARREN RIVERS, KENTUCKY.

The United States acquired possession of these locks and dams December 11, 1888, by purchase. At that date four of the locks, to wit, Nos. 1, 2, and 4, Green River, and No. 1, Barren River, were being operated. The river wall of No. 3, Green River, was down, having fallen into the river about the first of the year. No. 2, Green River, was and had been for years in a dilapidated condition, the river wall having yielded outwards, and the land wall was only kept from falling into the lock chamber by being anchored to cribs in rear of it filled with stone.

At No. 1, Barren, the lower end of the land wall had cracked badly and was in danger of falling at any time.

The first work evidently was that of restoring navigation by the reconstruction of the river wall at Lock No. 3, and as the lower end of the land wall of No. 1, Barren, was apparently unsafe it was deemed best to rebuild it at the same time. The above was done in time to reopen the river to navigation on November 10, 1890. At Lock No. 3, Green, however, there was a gap in the top of the land wall between the gates that was 30 inches deep and about 60 or 70 feet long, and owing to the river having risen suddenly to such an extent as to be within about 1 foot of the top of the upper gates, when the first steamer arrived from below, the gap in the wall had to be stopped so as to make the discharge through and over the uncompleted wall less than the capacity of the filling valves before the boat could be locked through. The gap was closed with dam timbers and the lockage effected with a delay of about 2 or 3 hours.

LOCK NO. 1, GREEN RIVER.

The lock walls at Lock No. 1, Green River, were raised to level of the walls of the upper bay, and the grounds on the land side of the lock graded and paved from the lock wall to near the high-water line. For years these grounds had been absolutely neglected, and were badly gullied and cut up; no sward could be maintained as the drainage was entirely on the surface. At a point just above the lock a small run, during the rainy season, discharged directly into the upper approach, bringing in earth washed from the hills. An earthen drain has been laid under the terreplein and through it the water from the run now passes to a point of discharge below the lock and where the earth it carries is utilized.

The ruins of the old guide walls have been removed and replaced by new structures carried down to rock, which renders it possible to dredge the approaches to their full depth without undermining the banks, and makes the cuts more permanent. It is proposed to replace the old style cumbersome winches, which are now used for operating the gates, with small capstans and rack bars, giving more room on the walls. The lower miter sill is in such shape that it will have to be repaired shortly. This will necessitate closing the river for a few days.

LOCK NO. 2, GREEN RIVER.

The lock walls here are in such condition that it has not been deemed expedient to attempt to repair them. The walls were not properly constructed in the first place. The land wall was made so thin that it commenced bulging out into the pit shortly after it was completed. It

was dressed off to retain the normal width of the chamber, and even after the navigation company acquired control of the system the face had to be dressed off again. Finally, the earth was excavated from the rear of the wall, and cribs filled with stone built in behind, to which the wall was anchored back by tie rods and face plates. It is undercut and leaks badly, while the chamber wall is separated from the lower wing wall by a crack several inches wide at the top and extending from top to bottom of wall.

The river wall is also badly cracked, and Captain Smallhouse, who was connected with the improvement of this river for years while the State had charge of it, and who was afterwards a member of the navigation company, being at one time its president, has told me that the gackinb was put in dry in the first place without mortar or grout. At the foot of the dam at one time several of the river face stones were knocked out, and he tells me that a large quantity of loose stones came out from the interior of the wall.

When the pit is filled water boils up under the river wall. It would be impossible to operate the lock were it not for the fact that about as much water leaks into the chamber through the land and head walls as goes out under the river wall. The navigation company was unable to pump out the chamber with a 13-inch pump.

I consider that this lock should be rebuilt, or rather that a new lock should be built on the river side of the old one, and I would recommend that the depth of water on the miter sills be increased to 6 or possibly 7 feet, so that coal can be carried into the first pool and thence into the Ohio, where the water in that stream is sufficiently high. By building the new lock on the river side of the old one navigation need not be suspended, and the length of spill of the dam is great enough to permit this being done.

The estimate for such a lock is as follows, and it can be built in one year if the money is appropriated at one time, to wit:

Stone:	
Dressed face, 1,362 cubic yards, at \$16.55.....	\$22, 541. 10
Quarry face, 1,718 cubic yards, at \$13.75	23, 622. 50
Backing, 4,291 cubic yards, at \$8.70.....	37, 331. 70
Coping, 250 cubic yards, at \$20.45.....	5, 187. 50
Special stone, 96 cubic yards, at \$18.65	1, 790. 40
	<hr/> 90, 473. 20
Upper and lower gates	4, 000. 00
Cofferdam and excavations	12, 000. 00
Guide cribs	10, 000. 00
Total	116, 473. 20
Engineering and contingencies	11, 647. 32
Total	128, 120. 52
or, including the cost of preparing foundation on rock, \$130,000.	

LOCK NO. 3, GREEN RIVER.

The lock has been restored with new gates and operating irons, and the land wall has been raised to the level of the upper bay. One hundred and forty feet of the old dam has been rebuilt from the crest downstream, and by the end of the season it is expected that the entire dam will be completed through to the abutment side and in a straight line. The old dam had an arm projecting downstream on the abutment side, its lower end being connected with the bank by a return parallel to the main

dam. This arrangement formed a storage bag for logs for a sawmill, but was otherwise very objectionable, as the cross spill produced a violent eddy below the lock which has caused the bank to cave very badly. It is proposed to blast out the rock below the dam on the abutment side and make the water way below the dam as free as possible. Both entrances to this lock have been troublesome from the very first, and the old guide cribs with some changes will have to be rebuilt.

LOCK NO. 4, GREEN RIVER.

But little has been done during the year besides some slight repairs to the dam. The old guide cribs are being rebuilt.

LOCK NO. 1, BARREN RIVER.

This lock has been restored and the lower slope of dam rebuilt.

This lock was built on a timber grillage resting on gravel.

At one time the lower end of the river wall was rebuilt and is now supported on piles. Whether the grillage timbers were disturbed next to the land wall at that time, or whether the arrangement had existed from the first, can not be determined; but when the lower end of the land wall had been taken down it was found that six or eight of the grillage timbers at the downstream end of the lock, instead of extending across the pit and under the land wall, stopped near that wall, and the lower end of the land wall rested on an independent grillage of its own, practically, as the connections were only short scarf joints and wooden pins.

The current from the discharge valves, emptying the lock, had washed away the gravel below the lock floor and undermined the short grillage timbers, causing the yielding of the wall. In all probability a like cause produced the former trouble with the lower end of the river wall.

The dredge boat turned over to the United States by the navigation company was an old-fashioned clam shell which could do very good work in soft digging, but was of no account in tearing out the wrecks of old cribs, etc., about the locks. She is being refitted with new machinery of the dipper pattern, and when completed will be in shape to do any kind of dredging to be required of her, as she will be able to work with dipper or clam shell.

The snag boat *Wm. Preston Dixon* has done very efficient service during the year, being a good towboat as well as snag boat. It was found necessary to raise her wheel about 8 inches, as it was ordinarily submerged too much, and this was done by putting cast-iron lifting pieces under the pillow blocks and raising the rear end of the engines to correct the lead.

Lieut. Wm. L. Sibert, Corps of Engineers, has been in local charge of the work on these rivers from the time they came under the control of the United States, and his work has been very commendable. His report, herewith, gives details of the work done during the past fiscal year.

2442 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Green and Barren rivers, Kentucky, improved by locks and dams, during the fiscal year ending June 30, 1891.

Months.	Lock No. 1, Green River.				Lock No. 2, Green River.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1890.								
July	\$321.20	\$1,312.65	\$76.74	\$1,710.59	\$196.20	\$143.95	\$11.54	\$351.69
August	343.20	5,442.29	102.30	5,887.79	218.20	321.95	24.05	564.20
September	225.60	8,848.88	102.12	9,176.60	225.60	3.00	24.03	252.63
October	219.60	4,703.47	39.65	4,962.72	219.60	8.57	31.50	259.67
November	233.60	4,429.66	113.10	4,776.36	233.60	.....	14.70	248.30
December	152.40	4,801.66	68.41	4,522.47	152.40	2.15	18.29	172.84
1891.								
January	220.60	.....	7.67	228.27	220.60	.....	7.67	228.27
February	283.60	.....	22.64	306.24	283.60	5.00	22.65	311.25
March	226.60	.....	28.29	254.89	226.60	.....	23.90	249.90
April	220.60	6.00	20.70	247.30	220.60	5.85	20.70	247.15
May	171.00	951.20	46.77	1,168.97	171.00	261.00	46.77	468.77
June	205.60	1,231.00	36.90	1,473.50	205.60	3.96	10.75	220.31
Total	2,823.60	31,226.81	665.29	34,715.70	2,573.60	745.43	255.95	3,574.98

Months.	Lock No. 3, Green River.				Lock No. 4, Green River.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1890.								
July	\$292.86	\$5,370.66	\$141.91	\$5,805.43	\$196.20	\$51.86	\$11.54	\$259.60
August	286.20	5,936.44	150.26	6,384.90	218.20	74.90	12.89	305.99
September	130.60	2,553.97	46.13	2,730.70	225.60	33.80	22.15	281.55
October	124.60	9,664.16	41.83	9,830.59	219.60	468.82	31.10	719.52
November	138.60	3,531.68	31.74	3,701.42	233.60	1.20	14.70	249.50
December	152.40	1,409.13	75.51	1,637.04	152.40	.....	26.42	178.82
1891.								
January	220.60	181.27	7.67	409.54	220.60	2.00	7.67	230.27
February	283.60	94.90	22.65	401.15	283.60	.....	22.65	306.25
March	226.60	65.65	34.74	326.99	226.60	6.20	25.05	257.85
April	220.60	86.35	20.70	327.65	220.60	1.20	20.70	242.50
May	171.00	1,013.96	65.70	1,250.66	171.00	.....	57.61	228.51
June	330.60	1,112.06	40.54	1,483.20	330.60	2,360.51	128.36	2,839.47
Total	2,590.26	31,019.63	679.38	34,289.27	2,698.60	3,020.49	380.74	6,099.83

Months.	Lock No. 1, Barren River.				United States snag boat, Wm. Preston Dixon.					
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries and labor.	Repairs.	Subsistence.	Supplies.	Equipment.	Total.
1890.										
July	\$226.20	\$5,676.05	\$83.13	\$5,985.38	\$817.55	\$33.30	\$223.98	\$260.98	\$102.69	\$1,438.50
August	123.20	4,532.02	67.89	4,723.11	767.67	.....	207.52	147.19	134.65	1,257.03
September	130.60	4,230.68	43.93	4,405.21	829.84	.....	260.09	180.92	.....	1,276.85
October	124.60	4,742.09	28.70	4,895.39	814.49	.....	154.08	154.30	.....	1,122.87
November	233.60	2,022.55	67.58	2,323.73	763.16	.....	185.11	202.56	.....	1,160.83
December	152.40	1,914.49	30.59	2,097.48	608.50	4.90	103.66	208.66	3.00	1,018.72
1891.										
January	220.60	3,263.67	7.67	3,491.94	478.31	10.60	.....	4.90	.....	493.81
February	283.60	1,182.12	25.04	1,490.76	405.00	167.82	.....	45.70	.....	618.52
March	226.60	801.05	35.65	1,063.30	422.25	232.12	.....	18.10	.....	672.47
April	220.60	1,151.10	21.10	1,394.80	529.75	417.77	.....	638.33	.....	1,585.85
May	171.00	712.82	62.88	946.70	793.83	61.58	237.46	389.17	.....	1,492.04
June	205.60	10.84	23.39	239.83	552.00	44.82	107.60	253.90	17.00	1,275.31
Total	2,318.60	30,239.48	490.55	33,057.63	8,172.35	972.91	1,485.50	2,514.71	257.34	13,402.81

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Green and Barren rivers, Kentucky, improved by locks and dams, etc.—Cont'd.

Months.	United States dredge Lormond.			Total.	United States dredge Wabash.			Total.
	Salaries and labor.	Repairs.	Supplies.		Salaries and labor.	Repairs.	Supplies.	
1890.								
July	\$222.00		\$20.80	\$242.80	\$337.65		\$20.80	\$358.45
August		\$2.05	22.00	24.05	607.25	\$11.65	14.58	633.48
September	265.50		22.50	288.00	316.10	10.00	106.62	422.72
October	294.00	11.86	32.10	337.96	364.40		9.75	374.15
November	240.00		27.12	267.12	335.00	4.51	4.66	344.17
December	167.17	10.75	126.24	304.16	310.50	83.21	12.02	355.73
1891.								
January					302.05	382.73	19.00	783.78
February	160.00	11.88		171.88	197.50	63.75	124.92	386.17
March	130.45		203.87	334.32	164.17			164.17
April	232.50			232.50				
May	308.40	55.94	13.40	377.74				
June	321.60	6,165.37	24.47	6,511.44				
Total	2,341.62	6,257.85	492.50	9,091.97	2,934.62	505.85	312.35	3,752.82

SUMMARY.

Lock No. 1, Green River	\$34,715.70	U. S. dredge Lormond	\$9,091.97
Lock No. 2, Green River	3,574.98	U. S. dredge Wabash	3,752.82
Lock No. 3, Green River	34,289.27	Two dump scows	4,025.17
Lock No. 4, Green River	0,099.83	One fuel barge	1,103.21
Lock No. 1, Barren River	33,057.63		
U. S. snag boat Wm. Preston Dixon	13,402.81	Grand total	143,113.39

REPORT OF LIEUTENANT WILLIAM L. SIBERT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Bowling Green, Ky., June 30, 1891.

MAJOR: I have the honor to submit the following report of operations on Green and Barren rivers, Kentucky, for the fiscal year ending June 30, 1891:

The work on these streams is carried on under the "indefinite appropriation for operating and care of canals and other works of navigation."

WORK DONE.

LOCK AND DAM NO. 1, GREEN RIVER.

All the work projected at this lock for fiscal year ending June 30, 1891, has been completed.

Repairs to lock.—Raised lower end of walls to same height as upper and widened both ends of lock walls so as to give more room for operating gates. Drove 728 linear feet of piling; cut 241 cubic yards of stone; laid 50 cubic yards of concrete and 406 cubic yards of masonry.

Grading and paving bank.—Moved 7,525 cubic yards of earth; laid 1,435 square yards of paving, and 258 linear feet of 24-inch sewer-pipe.

Repairs to guide cribs.—Dredged 5,225 cubic yards of material, preparing foundation; rebuilt upper land crib, 230 feet long; lower river crib 300 feet long; lower land crib, 190 feet long. All cribs same height as lock walls. Total cubic yards of crib work 8,702.

Repairs to abutment.—Constructed crib 140 feet long, extending downstream wing of abutment. Total cubic yards in this crib, 1,550.

Repairs to dam.—Made slight repairs to upper slope and placed 800 cubic yards of hickory lathe dust above dam as backing.

General work.—Cleared undergrowth from island; fenced Government property and constructed walks to lock-keepers' dwellings.

Mr. George H. Bratt was in local charge at this lock.

LOCK NO. 2, GREEN RIVER.

No work projected except dredging entrances.

Dredged 10,000 cubic yards of material from upper and lower entrances to lock; wheeled back 5,000 cubic yards of this material to prevent its sliding into entrances again.

LOCK AND DAM NO. 3, GREEN RIVER.

Repairs to lock.—Completed rebuilding river wall of lock and placed three courses of stone on that portion of land wall below upper gate recess. Cut 454 cubic yards of stone and laid 3,152 cubic yards of masonry. Constructed and hung four lock gates; placed iron hollow quoins in land wall of lock; built new miter walls and placed new upper and lower miter sills in lock. Removed stone and rubbish from bank below lock; dredged pit and entrances and opened lock to navigation November 10, 1890.

Repairs to dam.—Rebuilt a 140-foot section of lower slope of dam and a 30-foot section of upper slope; constructed a stone and dirt cofferdam around another 140-foot section and commenced to rebuild the lower slope of this section. Commenced to grade bank and split up 300 cubic yards of paving stone.

Mr. J. C. Thomas was in local charge at this lock.

LOCK AND DAM NO. 4, GREEN RIVER.

Constructed a stone and dirt cofferdam and placed new sheathing on an 80-foot section of dam.

LOCK AND DAM NO. 1, BARREN RIVER.

All work projected for this lock and dam has been completed, except paving bank. It was thought best not to pave bank until new fill behind land wall of lock had settled.

Repairs to lock.—Constructed a cofferdam running from lower end of river wall diagonally to shore. Pumped out lock pit; removed remainder of that portion of land wall of lock to be rebuilt. Removed sheathing from floor of lock, and old grillage foundation from that portion of lock wall to be rebuilt. A pile and concrete foundation was then prepared. The piles were driven to an average depth of 30 feet through a water-bearing sand and gravel, and sawed off 2 feet below bottom of lock wall. Material around heads of piles was removed to a depth of 3 feet and concrete, well rammed, inserted instead. The whole space was infested with springs. The piles were capped with 12-inch by 12-inch timber, and a platform of 12-inch by 12-inch timber laid on top. On this platform the lower end of lock wall was rebuilt. Cut 195 cubic yards of stone; laid 87 cubic yards of concrete, and 1,575 cubic yards of masonry.

A dangerous leak existed under the river wall of lock, out of which the water rushed when the pit was full. No remedy could be applied to what was already done, so the water was simply stopped from running under this wall and doing further damage. The bottom of lock was water-tight, except at this place, and that is below the dam. A leak, however, came from under miter wall at head of lock. The pit was sheathed with 3-inch oak, sized, outgauged, and calked. The sheathing did not extend to upper end of pit by 2 feet, and the upper end of sheathing was spiked down on oakum, so that head leak would rise on floor and not get under. The cofferdam around this leak on outside of wall having been strongly built was left, thus relieving floor from an under pressure from outside. The leak seems to be stopped entirely. Sheet piling was driven across lower end of lock pit and around lower end of new foundation for lock wall. Large stone were placed below this sheet piling to prevent scour from wickets.

New upper and lower miter sills were placed in lock. One lower lock gate constructed and hung. This lock was opened to navigation on the 26th day of August, 1890.

Repairs to dam.—Rebuilt entirely, 188 linear feet of the lower slope of dam; built new head gate for mill race.

Leak from upper pool to lower, under bluff.—Constructed a crib 40 feet long, 16 feet wide, and a foot higher than crest of dam, running parallel with the dam and 20 feet above it, for the purpose of holding broken stone and clay placed along bank to stop leak. Heretofore anything placed along bank was washed away on account of draw to mill race.

Filling excavation behind land wall of lock.—Ten thousand cubic yards of gravel and broken stone were used in filling this excavation. As the lock wall was built up,

the space behind it was filled with broken stone to a height of 10 feet, thus forming a drain.

Repairs to guide cribs.—Two guide cribs above, each 150 feet long, and two below, one 125 feet long and one 325 feet long, were constructed. Piles were driven to support river edge of lower land crib. All cribs same height as lock walls. Total number of cubic yards in the four cribs, 8,082.

Mr. B. O. Lermond was in local charge of this lock.

UNITED STATES DREDGE BOAT.

The dredge has been employed dredging lock entrances, preparing foundations for cribs, in laying the timber in cribs at No. 1, Green River, and in dredging material for filling excavation behind land wall at No. 1, Barren River. The placing of new machinery on dredge is now about completed.

UNITED STATES SNAG BOAT WM. PRESTON DIXON.

Work done.—Removed 1,035 snags from channel of river; cut 159 trees and deadened 245; launched and raised lower gates at No. 3 Green River; raised United States dredge *Wabash*. Towed from Cross Chutes to No. 3, Green River, 350 cubic yards riprap stone. Towed from Snowbird Point to No. 1, Barren, 200 cubic yards riprap stone; from Wrightsburg to No. 1, Green, 800 cubic yards sawdust; dredge and scows from No. 1, Barren, to No. 2, Green; derrick boat from No. 1, Barren, to No. 1, Green; dredge and scows from No. 2 to No. 3, Green; derrick boat from No. 1, Green, to No. 3, Green; dredge from No. 1, Green, to No. 3, Green; barge from No. 1, Barren, to Evansville, Ind., and return to No. 3, Green, with dredge machinery; derrick boat from No. 3, Green, to No. 4, Green.

Mr. W. S. Overstreet is master of this boat.

GENERAL WORK.

Constructed a fuel barge for United States snag boat; painted and made some minor repairs to United States snag boat.

Very respectfully, your obedient servant,

WM. L. SIBERT,
First Lieut. of Engineers.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF GREEN AND BARREN RIVERS, KENTUCKY, FOR FISCAL YEAR ENDING JUNE 30, 1891.

Articles.	1889.	1890.	1891.	Articles.	1889.	1890.	1891.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>		<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Beer.....	1,035	1,245	222	Lumber.....	970	2,486	9,000
Barrels, empty.....	8	53	52	Produce.....	1,450	501	184
Coal.....	57,245	45,904	49,000	Stone.....		788	14,752
Cement.....	200	168	600	Salt.....	485	1,014	1,104
Flour.....	368	773	1,363	Staves and heading.....			744
Grain.....	1,213	1,431	1,284	Ties, railroad.....	18,859	16,373	21,325
Hay.....	628	319	427	Tobacco, leaf.....	4,590	4,723	2,164
Handles.....	1,159	227	6,144	Timber, logs, etc.....	124,425	819,920	*500,000
Hides.....	22	19	30	Whisky.....	63	57	43
Hoop-poles.....		278	770	Passengers.....	654	972	1,434
Iron, manufacturing.....	118	98	253	Posts.....	13		
Live stock.....	277	482	1,285				
Merchandise.....	15,000	8,933	16,420	Tonnage.....	228,718	907,146	628,600

* The output of timber and logs for fiscal year ending June 30, 1890, was larger than usual, due to lack of water in previous years.

2446 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

List of boats plying on Green and Barren rivers, Kentucky.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	
City of Clarksville	Passenger ..	125	24	3.5	194.60
Evanaville	do	121	30	5	194.25
Blue Wing	do	119	24	4.2	111.83
Fannie	do	85.4	18.4	3.7	80.9
T. C. Woodward	do	65	9	4	33.50
Ida	do	60	14	3	22
Gertie Pool	Towboat. ...	90	23	3	54.26
Louise	do	76	18.5	3.8	40.80
D. A. Nisbet	do	105	20	3.6	64.68
Longfellow	do	112	19.6	4.8	93.50
D. A. Goodwin	do	103	20.3	3	69
G. B. Monthith	do	103.4	18.2	2.9	62.91
Henry Logan	do	105	21	3.5	83.8
Ingleside	do	81	14	4	36
Eleanor	do	60	16	2.8	14.64
Emma Ervine	Tug	79	15	4.4	41.98
Eugene	do	113	20	3.5	98.31
Isabella	do	95	22	4.8	66.24
Uncle Billy	do	89	18	3	79
Uncle Buck	do	67	18	4	32.34
Tip Top	do	60	14.7	2.4	20.49
Corine No. 2	do	63	14	4.6	24
Orphan Girl	do	80	15	4	39
Montezuma	do	49	12.1	3.5	16.19
U. S. snag boat Wm. Preston Dixon	Snag boat. ...	123.6	32	5	200

Report of lockages on Green and Barren rivers, Kentucky, for fiscal year ending June 30, 1891.

Locks.	Days operated.	Days suspended.	Going up.			Going down.				Total crafts and flats passing locks.	Total number of lockages.
			Steam-boats.	Barges and flats.	Miscellaneous.	Steam-boats.	Barges and flats.	Rafts.	Miscellaneous.		
Green river:											
Lock No. 1	251	114	437	224	85	438	232	1,082	67	2,565	2,314
Lock No. 2	263	102	360	179	15	378	179	721	9	1,671	1,541
Lock No. 3	141	224	112	28	60	113	29	372	41	755	662
Lock No. 4	322	43	204	73	73	195	68	87	61	761	817
Barren River:											
Lock No. 1	195	170	176	89	2	166	88	7	1	529	527
Total			1,319	593	235	1,290	596	2,269	179	6,481	5,861

Navigation through Locks Nos. 2 and 4, Green River, was suspended only for high water. Navigation was suspended for repairs 57 days at No. 1, Barren River; 11 days at No. 1, Green River, and 163 days at No. 3, Green River.

J J 3.

IMPROVEMENT OF ROUGH RIVER, KENTUCKY.

The river and harbor act of September 19, 1890, contained the following item, to wit:

Improving Rough River, Kentucky, \$25,000, to be expended in procuring the necessary land, commencing the construction of a lock and dam, and removing obstructions in the river from its mouth to Hartford, Ky., on the least expensive estimate recommended by Capt. James C. Post, Corps of Engineers, in his report of January 27, 1885.

The work having been assigned to my charge by Department letter dated September 20, 1890, a project for the expenditure of the appropriation was submitted under date of October 14, 1890. The project was as follows:

First. To definitely locate the site of the lock proposed, and purchase or have condemned the land needed about the lock and abutment.

Second. Clear the river obstructions, to wit: Overhanging trees on the banks, and snags, logs, and stumps in the bed of the river. The estimate for this was \$300 per mile, or \$9,000 for the 30 miles between the mouth of the river and Hartford. It is thought that the land needed about the lock and abutment can be purchased for from \$30 to \$40 per acre.

The above project was approved by the honorable Secretary of War under date of October 27, 1890.

Rough River is a crooked stream varying in width from 80 to 173 feet. Its banks are heavily timbered and in many places an ordinary type of river steamer would be stopped by overhanging trees. I have been over the lower pool, 8 miles, formed by backwater from Dam No. 2, Green River, and while there is a fair navigable depth up to the site of the old lock, the channel is much obstructed by snags, fallen trees, and saw logs that have sunk. The latter are so numerous that the finding and raising of them now constitutes a vagrant sort of industry among a certain class of raftsmen.

Shortly after the war a company built a timber and stone lock, with dam and abutment, about 8 miles from the mouth of the river, and steamboats from 110 to 125 feet long ran up the river as far as Hartford until the Green and Barren River improvements were leased to the Green and Barren River Navigation Company by the State of Kentucky. It is claimed that the excessive tolls charged by the navigation company effectually killed the commerce of Rough River, and the lock and dam were abandoned. The dam was only 90 feet long, and shortly afterward the river went around the abutment. Eventually the dam was torn out, so that now nothing but the ruins of the old lock remain.

The site of the old lock and dam is unsuited for a new structure on account of the washout and the necessity of removing the old ruins, and on this account a location for the proposed new lock and dam has been selected a short distance below and the lock placed on the left bank of the river; by this course it will be unnecessary to remove the old lock, as, being on the abutment side of the river, it will not be in the way of boats going up or down through the new lock. The top can be cut down so as not to interfere with rafts when the water is high enough for them to jump the dam.

The experience I have had in masonry work and dam building on the Green and Barren Rivers leads me to conclude that the estimates in Captain Post's report, referred to in the act of appropriation, are entirely too low, and, besides, the lock proposed would hardly be up to the modern requirements.

The proposed lock has the following dimensions, to wit:

	<i>Ft. in.</i>		<i>Ft. in.</i>
Length over all.....	191 6	Guard of lock.....	8
Length between hollow quoins..	145 9	Depth of water on lower miter sill	4
Height of walls.....	25 8	Depth of water on upper miter sill	6 8
Lift.....	9		
Height of dam.....	15 6		

The estimate of its cost is as follows:

Stone—	
Dressed face, 764 cubic yards, at \$15.95.....	\$12,185.80
Quarry face, 655 cubic yards, at \$13.15.....	8,613.25
Backing, 2,228 cubic yards, at \$8.10.....	18,046.80
Coping, 323 cubic yards, at \$20.15.....	4,674.80
Special, 46 cubic yards, at \$18.05.....	830.30
Total stone for lock.....	44,350.95
Upper and lower gates.....	3,000.00
Cofferdam and excavation.....	5,000.00
Dam complete.....	20,000.00
Abutment.....	4,000.00
Guide walls.....	8,000.00
Two lock houses, \$1,600 each.....	3,200.00
Total.....	87,550.95
Engineering and contingencies.....	8,755.10
	96,306.05
To this should be added the cost of the land.....	250.00
Total for lock and dam.....	96,556.05

In Captain Post's estimate the abutment was to be of wood. It is not considered advisable that it should be so constructed, as it would require renewal about every 10 years, and the depth to rock being only 6 feet below pool level, a stone abutment can be constructed with little trouble and at a comparatively small cost.

A working party is now engaged in deadening trees on the banks and in removing snags, logs, etc., from the river. The trees deadened this year can be cut down next year and will then float off when cut up.

So far 1,969 trees have been deadened, 91 tree tops cut up, and 290 logs cut up in the lower $2\frac{1}{2}$ miles of the river.

The amount of money that will be required to complete the project, that is, to clear out the channel, clear off the banks, and build the lock, is as follows:

Cost of lock and dam, etc., complete.....	\$96,556.05
Clearing banks and channel 30 miles at \$300.....	9,000.00
Total.....	105,556.05
Less amount already appropriated.....	25,000.00
Balance required to complete project.....	80,556.05

Money statement.

Amount appropriated by act approved September 19, 1890.....	\$25,000.00
June 30, 1891, amount expended during fiscal year.....	708.54
July 1, 1891, balance unexpended.....	24,291.46
July 1, 1891, outstanding liabilities.....	552.84
July 1, 1891, balance available.....	23,738.62
{ Amount (estimated) required for completion of existing project.....	80,556.05
{ Amount that can be profitably expended in fiscal year ending June 30, 1893.....	80,556.05
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.....	

COMMERCIAL STATISTICS FOR FISCAL YEAR ENDING JUNE 30, 1891, ROUGH RIVER, KENTUCKY.

Logs.....	Tons. 88,161
Lumber.....	9,000

List of boats plying on Rough River, Kentucky.

<i>Tugboat Uncle Buck.</i>			
Length.....	feet..	67	
Breadth.....	do ..	18	
Depth.....	do ..	4	
Tonnage.....	tons..	32.34	

J J 4.

IMPROVEMENT OF KENTUCKY RIVER, KENTUCKY.

The Kentucky River is a tributary of the Ohio, and empties into it at Carrollton, Ky., about midway between Cincinnati, Ohio, and Louisville, Ky.

The present project for the improvement of the river was adopted in 1879, the object being to repair the five locks and dams built by the State of Kentucky, and extend slackwater navigation for a draft of 6 feet, by the construction of additional locks and dams to Beattyville, a distance of 261 miles from the mouth of the river.

WORK DONE DURING THE YEAR.

Lock No. 6.—The site of this lock is located 32 miles above Frankfort, Ky., on the right bank of the river.

The cofferdam inclosing the site is completed and the necessary excavation to rock inside has been made. The work has so far advanced that the laying of the foundation can be commenced now within a short time. The abutment for the dam is completed, and the contracts for timber to construct the dam let.

Beattyville.—Under date of February 25, 1891, work on this lock was suspended by order of the Chief of Engineers, U. S. Army, and instructions given to continue the old dam across to the Proctor bank, in order to give slackwater navigation during the low-water season up to the junction of the Middle and North forks of the Kentucky River, the nearest point on the Kentucky Union Railway to Beattyville. This work is now in progress and will be completed during the present season.

For details concerning the work at Lock No. 6, and at Beattyville, attention is invited to the report of Assistant Engineer R. S. Burnett, herewith.

Money statement.

July 1, 1890, balance unexpended.....	\$5,276.99
Amount appropriated by act approved September 19, 1890.....	180,000.00
	<hr/>
June 30, 1891, amount expended during fiscal year	185,276.99
	33,460.40
	<hr/>
July 1, 1891, balance unexpended.....	151,816.59
July 1, 1891, outstanding liabilities.....	\$16,267.11
July 1, 1891, amount covered by uncompleted contracts	9,660.00
	<hr/>
	25,927.11
	<hr/>
July 1, 1891, balance available.....	125,889.48
	<hr/>
{ Amount (estimated) required for completion of existing project.	1,674,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	500,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

2450 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of bids received and opened June 1, 1891, by Maj. D. W. Lockwood, Corps of Engineers, for improving Kentucky River, Kentucky, at Lock No. 6.

No.	Name and address of bidder.	Portland cement, 1,000 barrels, (per barrel).	American natural cement, 6,000 barrels, (per barrel).	Total.	Remarks.
1	J. B. Speed & Co., Louisville, Ky...	\$4.10	\$1.20	\$4,100.00 7,200.00	In accordance with terms of specifications. With the proviso that the cement is to be inspected at Louisville and cost of inspection paid by the United States.
2	J. B. Speed & Co., Louisville, Ky...	3.70	1.01	3,700.00 6,000.00	
3	Gray & Church, Frankfort, Ky....		1.94	11,640.00	
4	The Buckeye Portland Cement Co., Bellefontaine, Ohio.	3.50		3,500.00	
5	Erskine W. Fisher, New York City.	2.68		2,680.00	
6	Jas. E. McCracken, Cincinnati, Ohio.	3.60	1.74	10,440.00 3,600.00	

The bids of Erskine W. Fisher for Portland cement, and J. B. Speed & Co. for American natural cement, at \$1.01 per barrel, were accepted.

REPORT OF MR. R. S. BURNETT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Salvisa, Ky., July 1, 1891.

MAJOR: I respectfully submit the following report on the improvement of the Kentucky River, Kentucky, for the fiscal year ending June 30, 1891:

LOCK NO. 6.

Early in May borings were made on the lines of proposed cofferdam to determine the depth through the bed of the river to solid rock; this was found to be at an average depth of 16 feet.

Four barges were constructed by hired labor and purchase of material by circular letter. Two of these barges were constructed 5 by 13 by 100 feet, to be used in handling material necessary for the construction of Lock No. 6; the other two were constructed 5 by 24 by 85 feet, to be used at Beattyville in handling material for that lock. As this lock was abandoned, the barges have been used at Lock No. 6 to great advantage. The barges were constructed out of white pine.

A new hull 24 by 6 by 65 feet was constructed out of long-leaf yellow pine for the old dredge *Ward*. This dredge had been transferred from the Louisville and Portland Canal several years ago; at the time it had been condemned. The hull was 18 years old and entirely rotten. The old machinery was removed and set up in the new hull, a house was built over machinery, and the entire dredge painted. When this work had been completed, the latter part of May, the dredge was sent to Lock No. 6 to excavate for foundation for lock walls.

The dimension stone stacked by the contractors immediately behind the site for the lock was in danger of slipping into the river when the excavation was made for the foundation of the land wall, and as the stone had not been systematically separated, which would cause great delay in setting, it was moved on land above cofferdam and restacked.

A railroad track 3 feet 6 inches gauge was built leading to the several stacks of stone and to the head of the cofferdam.

Excavating for the foundation of the inside wall has been increased a large amount by the slipping of the bank during rise in the river June 21, 1891. The general excavating work has been increased about 10 per cent. by deposit and slipping sides of the cuts made by dredges during the same rise.

The following buildings were constructed by hired labor and purchase of material in open market, One office, one cement shed, one tool house, one carpenter house, one blacksmith shop, two water closets.

Work was commenced at this lock May 14, 1891. The following is a detailed statement of work done:

COFFERDAM.

Drove 206 piles to an average depth of 14 feet; spiked as wailing to piles 2,254 linear feet 5 by 12 oak; constructed 1,127 linear feet of cofferdam.

Backing cofferdam.—Placed as backing 11,184 cubic yards of clay, gravel, and earth; 18,576 cubic yards of hard-wood brush fascines; placed 8 shores 5 by 12 by 18 from upper inside face of cofferdam to piles 15 feet below as inside bracing to up-river face.

Dimension of cofferdam.—Upper return wing, 162 feet; lower return wing, 140 feet; river face, 327 feet; average height above pool water, 7 feet. Construction of cofferdam completed June 16, 1891.

Pumping.—Built platform 16 by 24 feet inside cofferdam for 8 and 12 inch pumps; built platform on cofferdam 14 by 24 feet for engine; built platform inside cofferdam for engine 16 by 24 feet. Commenced pumping cofferdam June 17, 6 o'clock p. m. Pumped cofferdam out June 18, 4 o'clock p. m. Excavated June 19 and 20. Broke shaft of pumping engine June 21, 12 o'clock p. m. Snag boat *Kentucky* stopped pumping with 12-inch pump June 21, and left for lower river with the dredge *Ward*. Cofferdam flooded by 9-foot rise in river June 23 and 24. Snag boat *Kentucky* commenced pumping second time June 25, 8 o'clock p. m. Pump broke June 26, 10 o'clock a. m. Repumping June 26, with 8-inch pump that had been stopped for repairs. Completed pumping cofferdam second time June 28, 4 o'clock p. m.

Dredging and excavating for foundation of lock walls.—Average depth of excavating for outside wall, 16 feet; for inside wall, 8 feet; head miter wall, 15 feet; lower miter wall, 10 feet. The material excavated for outside wall is hard gravel; head miter wall one-half gravel, one-half sand and earth; inside wall three-fourths earth, one-fourth sand, gravel, and rock; lower miter wall hard gravel, sand, and rock.

Material removed.—Removed by dredges 25,360 yards of material, by wheelbarrows 8,802 cubic yards, and by derrick, boat, and dump buckets, 340 cubic yards.

ABUTMENT.

Excavating commenced May 16, 1891. Average depth of cut to solid rock for river wing, 48 feet; return wing, 63 feet; width of cut at top, 70 feet; at bottom, 16 feet. Length of river wing, 45 feet; return wing, 45 feet. Length of masonry, river face, 40 feet; width at bottom, 12 feet. Length of return wing, 40 feet; width at bottom, 12 feet.

The foundation of the river face is solid rock, averaging 6 inches below pool water. Return wing into the bank first 10 feet level of pool water; second 10 feet 2 feet above pool water; third 10 feet 4 feet above pool water; fourth 10 feet 9 feet above pool water.

Masonry completed on river face 6 inches above the top of lock walls; return wing 21 inches above height of lock walls.

Work done.—Removed in excavating for abutment 9,365 cubic yards of clay, earth, sand, and loose rock; 4,830 gallons of water.

Shoring sides of cut.—Placed 2 shores 8 by 10 feet; 2 shores 12 by 20 feet; 4 shores 12 by 16 feet; 4 braces 35 feet; 4 braces 24 feet; and 2 braces 14 feet in length in cut to prevent bank from caving.

STONWORK.

Dimension stone cut.—Cut the following amount of dimension stone:

	Cubic yards.	Cubic feet.
Quarry face	297	20
Backing stone	398	14
Coping stone	3	8

Dimension stone set.—Commenced setting stone on abutment June 5, 1891. Set the following amount:

	Cubic yards.	Cubic feet.
Quarry face	283	1
Backing stone	355	25
Spawls and riprap	173	.....

Handled 795 cubic yards of rough stone in selecting stone for cutting.

Rehandling stone for lock.—Removed on cars, assorted and restacked, 2,997 cubic yards of cut stone.

DREDGING FOR DAM.

Excavating and opening a channel through bar immediately opposite and below cofferdam for the purpose of drawing water off and changing the current of the river from the cofferdam.

Removed 3,470 cubic yards of sand, gravel, and boulders.

RAILROAD TRACK.

Constructed trestle for railroad track from upper quarry to head of cofferdam 100 feet long, 14 feet wide, and 8 feet high.

Constructed trestle from cement shed to river derrick 27 feet long, 4½ feet wide, and 6 feet high. Built trestle in old quarry 65 feet long, 6 feet wide, and 14 feet high.

Track.—Laid and ballasted, 2,413 linear feet of double track and switches. Used 1,655 cross-ties 6 feet long, 24 switch-ties 18 feet long, and 873 cubic yards of broken stone as ballast.

Tore up old track, relaid and reballasted 1,300 linear feet of single track. Excavated 299 cubic yards of earth for track.

CARPENTER WORK.

Dressed and framed material and constructed the following buildings: 1 office, 1 blacksmith shop, 1 tool house, 1 cement house, 1 cement shed, 1 carpenter shed, and 2 water-closets.

Framing traveler timbers.—Made and mortised 208 posts, 8 by 8 by 16; 199 braces, 3 by 4 by 16; 77 caps, 5 by 12 by 9; 60 sills, 8 by 8 by 9; 66 posts, 8 by 8 by 18; 8 caps, 5 by 12 by 18; 122 range sticks for track, 8 by 8 by 20; 42 caps, 5 by 12 by 6; 21 caps, 5 by 12 by 16; and 5 sills, 8 by 8 by 16.

General carpenter work.—Made 2 workbenches; 2 floats, 4 by 60 feet; 8 cavils; 2 chocks for derrick boat; 2 tool boxes, 4 by 4 by 8 feet; placed 3 windows in tool house, and 2 windows in blacksmith shop; made spud for dredge *Ward*, 26 feet long, 11½ by 11½ inches, and placed same in position; made 2 small derricks and placed same on barge; put handles in 50 picks, 18 adzes, 20 hammers, and 16 mattocks; made 5 booms, 3 masts, 2 stiff legs, and 1 mast seat for derricks; made 4 stone car frames; 4 car brakes; 1 desk, 2 tables; 3 hoisting trays (for unloading cement); 6 push poles; 1 box 5 by 10 by 15 feet for mixing cement; 10 wheelbarrow handles; 4 screen doors; 4 stone and concrete rammers; 5 screen frames for office windows; 1 grindstone frame; rehandling tools; setting up pumps; making boxing for covering pump belting.

Derricks.—Raised, rigged, and placed in position 16 derricks on lock side of river and 2 derricks on the abutment side; removed 2 stiff legs, 2 masts, and 2 booms from lower end of lower quarry into river and floated them to upper quarry, hoisted in position in quarry for handling stone for abutment; erected and rigged derrick on river bank near lower end of upper quarry for handling stone; dismantled and lowered derrick in lower quarry and removed same to river bank, and reset it for handling dimension stone for abutment and lock; removed 100 cubic yards of waste stone in setting up derricks; moved horse-power and engines and resetting same for working derricks; tightening, overhauling, and putting up guy lines; splicing wire, fall, and guy lines; oiling guy lines; moved and reset 4 derricks; placed in position 11 horse-powers; placed and anchored 13 stiff legs to derricks; used 85 cubic yards of riprap stone in weighting stiff legs down.

PUMPS.

Overhauled and set up one 8-inch pump and engine. Removed 12-inch pump from snagboat *Kentucky* and set same on platform inside of cofferdam, repairing and overhauling same; removed 10-inch pump and pumping engine to platform on cofferdam, overhauled and set up same; removed 20 cubic yards of earth in excavating for foundation for boiler set on river bank for running 10-inch pump; built fire box for same 5 by 3 feet; placed boiler in position; removing engines, boilers, and pumps during rise in river, and reset same when river fell; repaired and reset shaft of 8-inch pumping engine; built frame for shafting of 10-inch pump, 24 feet high; built frame for pump to set on.

GENERAL WORK.

Cleaning and grubbing brush from Government land for constructing buildings; building foundations for buildings; removing materials from barges to storehouses;

working horse-powers and engines handling stone and other materials; hauling with lines dump scows and barges after they were unloaded to dredges digging ditch around buildings and behind cofferdam for purpose of drainage; built 2 stone forges in blacksmith ship; sharpening, wrapping butts, and putting shoes (iron) on piles; set up hoisting engine on abutment side of river, and placed 2 horse-powers in position for working derrick; excavated 6 cubic yards of spawls in lower quarry for setting engine; removed 210 linear feet of piling from top of bank to river; boring holes in and excavating around 2 large stumps in side of cofferdam; charging holes with dynamite and blasting out stumps; boated 150 bushels of coal from Mundy Landing to Lock No. 6. Laid 738 linear feet of 2 by 12 inch plank for wheelbarrow runs; loaded on barges 1,704 cubic yards of clay and earth at site of abutment, removed across the river and placed behind cofferdam as backing; loaded barges at Frankfort with lumber and material, towed to Lock No. 6, and unloaded same; snag boat, dredge *Willie*, and diver removed one large oak log 8 feet thick at butt, 50 feet long, lying across water line of cofferdam. Cut 18,576 cubic yards of brush, bundled same into fascines 2 by 12 feet with wire, boated to cofferdam and placed them in position as backing; unloaded 160 cubic yards of earth from barge below cofferdam. Removed from barges and placed in cement shed 1,210 barrels of cement. Cleaning and overhauling engines; repairing engines; whitewashing buildings; pumping barges and pile driver; handling barges and scows; carrying water; unloaded in river below cofferdam 13,090 cubic yards of excavated material; removed 115 cubic yards of earth in preparing site for restacking stone; excavated 25 cubic yards of earth in constructing roadway between lock and ferry; made 2 culverts in roadway; removed 35 cubic yards of earth in grading bank around carpenter shop; removed 90 cubic yards of sand and gravel from around suction pipes of pumps; removed 65 cubic yards of earth in trenching around boiler on river bank at lower end of cofferdam; cut down 2 large trees near cement shed and removed same; hoisted freight from barges to tool house; loaded 2,800 bushels of coal on barges and coaled engines and dredges; removed engine in lower quarry four times for handling stone; removed lumber and other materials out of reach of high water; hoisted 240 barrels of cement from river bank to shed on abutment side; hoisted and loaded 782 cubic yards of stone on barges, transported across river and unloaded same for the abutment; loaded 67 cubic yards of spawls and 75 cubic yards of riprap stone on barges, transported and unloaded same for abutment; screened 604 barrels of sand for making mortar; removed on cars from upper quarry 87 cubic yards of cut stone; hoisted and placed on river bank on abutment side 624 linear feet of piling; dug trench from spring above upper quarry to top of lower quarry, 1,200 feet long, and laid $\frac{1}{4}$ -inch gas pipe for supplying drinking water for employes; removed float 60 feet in length from inside of cofferdam; pumping cofferdam; caring for tools and plant; blacksmithing, watching, etc.

UNITED STATES SNAG BOAT KENTUCKY.

The snag boat *Kentucky* towed barges loaded with material for constructing cofferdam and lock; towed dredges and pumped cofferdam.

The boilers cracked twice while engaged at this work, and she is now laid up for repairs to her boilers.

UNITED STATES DERRICK BOAT.

The United States derrick boat drove all piles for cofferdam; handled all stone for the abutment; hoisted engines and pumps in position; excavated from inside of cofferdam with dump buckets; unloaded cement and all materials for the work; handled barges and dumped scows; hoisted and set up derricks on river bank, and doing general work around cofferdam and abutment.

UNITED STATES DREDGE BOAT WILLIE.

The United States dredge boat *Willie* dredged the following amount of material: Eighteen thousand and fifty-one cubic yards of earth, gravel, clay, and sand for foundation of lock walls.

Excavated 1,875 cubic yards of material and placed same as backing to cofferdam.

Excavated 210 cubic yards of earth and clay for dam.

UNITED STATES DREDGE BOAT WARD.

The United States dredge boat *Ward* dredged the following amount of material: Seven thousand eight hundred and one cubic yards of clay, gravel, and sand for foundation of lock walls.

BEATTYVILLE DAM.

The cofferdam constructed last year was not damaged by the spring freshets. A heavy deposit of sand took place above, inside, and below cofferdam.

The spring freshets washed away some of the backing from above the fixed portion of the dam, together with some of the sheathing; 69 cubic yards of clay, stone, and gravel were used as backing. Sheathing replaced, using 86 linear feet of hewed oak timber, nineteen pieces of 3-inch oak lumber, and 1,555 square feet of 2 and 3 inch oak lumber.

Complying with your instructions, the work of extending the dam through the cofferdam, across the old passes to the Proctor Bluff, was started in May. Contracts were made for material and the work of pumping out the cofferdam, excavating, and removing old timbers to secure a substantial foundation was commenced.

The cofferdam was flooded by a rise in the river June 21, height of water being 9 feet 7 inches. Considerable deposit was made inside cofferdam, but slight damage was done.

Cofferdam was pumped out June 25, and work resumed.

The following is a statement of work done:

Excavating for foundation of extension of dam.—Removed 32,259 feet, B. M., sawed oak lumber; 707 linear feet of hewed timber; 3,068 cubic yards of sand; 122 cubic yards of clay; 29 cubic yards of stone, and 1,703 assorted spikes from inside of cofferdam.

Proctor Bank.—The extreme high water caused this bank to slide and the old protection work to give way, endangering the office building, and filling inside of cofferdam. The bank was excavated, wheeled above cofferdam, and deposited as backing.

Removed the following from the Proctor Bank: One thousand two hundred and sixty-three cubic yards of clay, 18 cubic yards of riprap stone, 2,020½ linear feet of hewed oak timber, 4,126½ feet, B. M., oak sheathing, 445 assorted spikes.

General work.—Placed pump engine and pump inside of cofferdam; pumping cofferdam; constructed water tank for supplying engines with water; rigged and set up derrick on cofferdam; laid wheelbarrow runs; made pile-driver leads; calked flatboat; received and restacked lumber for dam; repaired skiffs; removed old hewed oak timber from dam and stacked same on Proctor Bank; removed spikes and drift bolts from old timbers; removed necessary engines and tools from Rock Shoal Quarry to Beattyville, and shipped the balance of tools, etc., to Lock No. 6; made eight push poles and two coal boxes; blacksmithing, watching, handling tools, and general care of United States engineer property.

Cement.—The 5,000 barrels of cement damaged by high water February 26, 1890, were examined and all barrels found damaged. An effort was made by your direction to sell cement, but there were no bidders.

Rock Shoal Quarry.—No work has been done at this quarry since suspension of work last September, with the exception of restacking a small amount of stone, and care of United States property.

The two large boarding houses constructed for the use of employes and a store building were destroyed by fire about 7 o'clock p. m., December 11, 1890. From statement of watchman it appears that the fire originated in the store building, caused by an explosion of a coal-oil lamp while the occupants were at supper. When the fire was discovered it had made too much headway to be extinguished. A high wind prevailing carried the flames to the boarding houses. Barrels of water had been placed on the roof of boarding houses, but they could not be used. A few old tools were destroyed, and some of the cut stone contiguous to the buildings were cracked by the intense heat.

General remarks.—The citizens of Beattyville are very solicitous to have the dam raised 2½ feet in order that they may have sufficient depth of water for transportation of materials and supplies to and from the Kentucky Union Railroad bridge, about 3½ miles above the dam. As this road is the only accessible outlet or source of communication with the outside world, and as under the present circumstances at a pool stage of water the steamboats running from Beattyville to the railroad bridge, and drawing less than 2 feet of water, can not get over the shoals at and near the mouth of the Middle Fork, and as several large sawmills have located above the dam on the North Fork, and can not ship their lumber to market, it appears to me that some relief should be afforded if practicable. Raising the dam would be detrimental to the rafting interest, and to make this additional height movable so that it could be lowered during freshets would be expensive and probably unsatisfactory to all interests. I would respectfully recommend that the shoals be deepened by constructing three or four wing jetties, contracting the river channel; these jetties to be constructed about 2 feet above pool water out of logs and brush mattresses and riprap stone. The opposite bank would require but little protection work, as it

is of such nature that it would scour but little. The cost of these jetties would not exceed \$500 each.

Mr. John H. Westerfield, assistant engineer, in local charge of this work, successfully conducted it during the past year.

Respectfully submitted.

R. S. BURNETT,
Assistant Engineer.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS, KENTUCKY RIVER, KENTUCKY (UPPER AND LOWER RIVERS),
FOR FISCAL YEAR ENDING JUNE 30, 1891.

Articles.	1890.	1891.	Articles.	1890.	1891.
	<i>Tons.</i>	<i>Tons.</i>		<i>Tons.</i>	<i>Tons.</i>
Coal.....	89,562	89,752	Miscellaneous merchandise..	19,554	21,739
Flour.....	1,503	1,744	Passengers.....	1,995	2,023
Grain.....	6,991	14,279	Salt.....	909	1,002
Hay.....	4,407	500	Timber.....	4,682	3,761
Iron, manufacturing.....	1,903	712	Tobacco.....	2,783	5,636
Live stock.....	2,350	3,065	Whisky.....	4,142	4,306
Lega.....	158,903	224,844			
Lumber.....	10,670	15,256	Total.....	310,354	389,219

List of stern-wheel boats plying on the Upper Kentucky River, Kentucky.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	
Ingomar.....	Packet.....	111	19.5	3	74.61
Favorite.....	.....do.....	109	15	3	43.64
Benny S.....	.....do.....	64	8	1.8	7.18
Dora No. 2.....	.....do.....	78	14	3	34.46
Ada V.....	.....do.....	92	13.6	2.2	21.32

JJ 5.

OPERATING AND KEEPING IN REPAIR THE FIVE LOCKS AND DAMS ON
KENTUCKY RIVER, KENTUCKY.

The United States acquired possession of these locks and dams in 1880, at which date they were in a more or less crippled condition, the timber of the dams being badly decayed and the lock gates and operating machinery in such a state as to need absolute removal or extensive repairs.

Some of the dams have been entirely rebuilt, the others nearly so. Guide walls above and below the locks have been constructed, and the banks about the locks and abutments protected by timber cribbing to prevent erosion.

At present there is good slack-water navigation from the Ohio River to Oregon, a distance of 99 miles.

The work of the past year has been carried on with a view to establishing the security of the locks, dams, and accessories, and that projected for the coming fiscal year is of the same character.

The new gridiron valves have been found to work very successfully. The leakage is comparatively slight, while the old butterfly valves, especially when worn, leaked very badly.

Extensive repairs will be required to the United States snag boat *Kentucky*. Her boilers have let down twice within the past 2 months; they have been patched and the United States steamboat inspectors will examine them soon, which will determine whether they can be continued in use.

The entire bottom requires renewal and the entire forecastle, including the butting beam, will have to be replaced. The capstan engines are under the forecastle deck and the escaping steam has rotted away the deck and deck beams.

For details concerning the work done during the past fiscal year attention is invited to the report of Assistant Engineer R. S. Burnett, herewith.

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Kentucky River, Kentucky, improved by locks and dams, during the fiscal year ending June 30, 1891.

Months.	Lock No. 1.				Lock No. 2.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1890.								
July	\$230.00	\$426.85	\$9.32	\$666.17	\$230.00	\$67.15	\$5.07	\$302.22
August	255.00	279.05	5.53	539.58	210.00	1,120.83	5.54	1,336.37
September	230.00	822.16	1.23	1,053.39	185.00	1,084.91	1.23	1,271.14
October	183.33	1,109.03	14.52	1,966.88	210.83	1,237.27	9.07	1,457.17
November	115.00	763.31	9.22	887.53	165.00	690.26	9.22	864.48
December	206.20	271.78	3.80	481.78	206.20		3.80	210.00
1891.								
January	233.00	11.65		244.65	233.00	1.80		234.80
February	165.00	6.24		171.24	165.00	2.00		167.00
March	165.00	165.80		330.80	165.00			165.00
April	163.00	2.50	12.10	177.60	163.00		2.60	165.60
May	233.00	30.46	4.56	268.02	233.00	89.75	4.56	327.31
June	233.00	13.50		246.50	233.00	28.75		261.75
Total	2,411.53	3,962.33	60.28	6,434.14	2,399.03	4,322.72	41.09	6,762.84

Months.	Lock No. 3.				Lock No. 4.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1890.								
July	\$230.00		\$5.07	\$235.07	\$230.00	\$30.66	\$7.07	\$267.73
August	255.00		5.54	260.54	255.00		5.54	260.54
September	230.00	\$104.31	1.23	335.54	230.00	23.55	1.23	254.78
October	233.33	343.62	9.07	586.02	233.33	497.40	12.07	742.80
November	165.00	107.48	9.22	281.70	165.00	115.97	10.73	291.69
December	206.20		3.80	210.00	206.20	34.95	3.80	244.95
1891.								
January	233.00	1.80		234.80	233.00	74.97		307.97
February	165.00	22.20		187.20	165.00	42.90		207.90
March	165.00	12.66		177.66	165.00	25.20		187.20
April	163.00	10.50	2.60	176.10	163.00	13.80	2.60	179.40
May	233.00	15.00	4.56	252.56	233.00	93.31	7.55	333.86
June	233.00			233.00	233.00	51.15		284.15
Total	2,511.53	617.57	41.09	3,170.19	2,511.53	1,000.86	50.58	3,562.97

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Kentucky River, Kentucky, improved by locks and dams, etc.—Continued.

Months.	Lock No. 5.				United States snag boat Kentucky.				
	Salaries.	Labor and materials.	Current and contingent expenses.	Total.	Salaries.	Current and contingent expenses.	Repairs.	Supplies.	Total.
1890.									
July	\$230.00	.....	\$5.07	\$235.07	\$372.00	.....	\$107.48	\$130.80	\$1,110.37
Aug	255.00	\$174.50	93.58	523.08	1,011.32	\$6.50	85.37	28.32	1,131.51
Sept	230.00	236.20	1.22	467.42	1,013.98	.....	.....	276.43	1,290.41
Oct	233.34	430.65	9.08	673.04	955.00	10.00	1.51	159.57	1,128.08
Nov	165.00	162.95	9.22	337.17	1,014.00	.....	3.84	46.92	1,064.76
Dec	206.20	38.70	3.80	248.70	857.50	.....	.....	4.80	862.30
1891.									
Jan	233.00	94.55	.....	327.55	414.50	.....	.....	180.00	594.50
Feb	165.00	49.45	.....	214.45	437.00	.....	.....	.....	437.00
Mar	165.00	90.00	.....	255.00	580.00	.....	.....	.....	580.00
Apr	163.00	186.70	4.60	354.30	.....	.....	.....	157.12	157.12
May	199.67	131.00	4.55	335.22	.....	.....	501.79	307.15	808.94
June	183.00	156.50	7.00	346.50	1,036.00	.....	125.98	157.50	1,319.48
Total	2,428.21	1,751.20	138.12	4,317.53	8,191.30	16.50	825.97	1,448.70	10,482.47

Month.	United States dredge Willie.			
	Salaries and labor.	Repairs.	Supplies.	Total.
1890.				
July	\$368.45	\$390.21	\$177.02	\$936.28
August	366.50	.....	.....	366.50
September	145.00	.....	.....	145.00
October	245.00	.....	96.59	341.59
November	145.00	1.60	10.40	157.00
December	95.00	.....	.....	95.00
1891.				
January	95.00	.....	.....	95.00
February	95.00	.....	.....	95.00
March	88.66	.....	.....	88.66
April	188.99	.....	27.90	216.89
May .....	.....	.....	18.00	18.00
June	163.83	10.16	72.60	252.59
Total	1,994.43	407.97	403.11	2,805.51

SUMMARY.

Lock No. 1, Kentucky River	\$6,434.14	U. S. dredge boat Willie	\$2,805.51
Lock No. 2, Kentucky River	6,762.84	Lock-keeper's Dwelling, Lock No. 2	2,015.40
Lock No. 3, Kentucky River	3,170.19	Lock-keeper's Dwelling, Lock No. 3	2,136.96
Lock No. 4, Kentucky River	3,562.97	Lock-keeper's Dwelling, Lock No. 5	2,527.12
Lock No. 5, Kentucky River	4,317.53		
United States snag boat Kentucky	10,482.47	Grand total	44,215.13

REPORT OF MR. R. S. BURNETT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Salvisa, Ky., June 30, 1891.

MAJOR: I respectfully submit the following report on the operating and care of canals and the maintaining and preserving of navigation on the Kentucky River for the fiscal year ending June 30, 1891:

All repairs at the several locks which were contemplated in the project for the fiscal year ending June 30, 1890, and which could not be made on account of high water during that year have been completed, also all work contemplated in the project for fiscal year ending June 30, 1891, with the exception of the new dwellings for lock-keep-

ons at Locks Nos. 2, 3, and 5. These dwellings are now under construction by hired labor and purchase of material in further season and will be completed by the 1st of August, 1891.

The locks and dams are all generally in good condition; some slight damage has been done by heavy drift to the guide piers and operating irons. But one serious accident has occurred during the year and that was at Lock No. 1. On March 5, 1891, during an extreme high rise in both the Kentucky and Ohio Rivers, and a large amount of drift running over the lock walls, the lower shore gate was wrenched from its fastenings and was carried a short distance below the lock. As soon as the river fell and reached the foot of the lock walls the gate was found and rebung by the United States snag boat Army.

The Louisville and Nashville Railroad Company have raised their bridge crossing the Kentucky River at Worthville, Ky., 3 feet, and contemplate raising it 6 inches more this season. No alteration has been made by this company to its bridge at Frankfort, Ky.

The corporations controlling the wooden bridge at the foot of St. Clair street, Frankfort, Ky., have failed to make any alteration to that bridge.

The following is a detailed statement of the work done during the past year:

LOCK NO. 1.

Upper shore guide wall.—Grading and paving back behind wall: placed 1,374 cubic yards of earth, clay, and gravel; laid 1,036 square yards of paving, and placed 261 cubic yards of sand on same; cut, dressed, and placed in position behind paving 282 linear feet of flagging.

Lock wall.—Grading and paving behind wall: placed 486 cubic yards of earth, clay, and gravel; laid 183 square yards of paving; cut, dressed, and placed in position 36 linear feet of curbing; set 38 linear feet of drainpipe above paving; repointed defective joints on lock wall.

Lock gates.—The upper lock gates were taken out and the old butterfly valves were removed and replaced with 4 new gridiron valves; removed old hand rails and put in new rails; old pintle seats removed and new ones placed in position; repainted gates.

Lower river guide wall.—Placed 52 cubic yards of riprap stone filling and laid 67 cubic yards of paving stone.

Lower shore guide wall.—Placed 561 cubic yards of riprap stone filling in wall and laid 119 cubic yards of paving stone.

Dam.—Removed defective sheathing and placed in new sheathing.

Abutment.—Placed 52 cubic yards of stone on upper face of abutment to stop small leak.

General work.—Quarrying and transporting stone from quarry at Drennon, Ky., to lock; painting and penciling chimneys and foundation of lock house and office; built 400 linear feet of fence around Government property; cleaned and repaired cistern; constructed a return protection wall into the bank at lower end of lock; set 70 cubic yards of dimension stone; secured lower gates back in the recess with heavy chains; removing and repairing operating irons; cleaning Government premises of vegetation and mud and drift from lock walls.

Dredging.—Removed from lock entrance 2,155 cubic yards of material.

General remarks.—There was no suspension of navigation except for high water. The lock walls were submerged by back water from the Ohio and high water in the Kentucky River during the months of January, February, March, and April, 90 days.

Highest water occurred February 26, upper gauge reading 50.5 feet; lower gauge, 26.8 feet. Lowest water occurred August 6; upper gauge, 8.5 feet; lower gauge, 6.8 feet.

LOCK NO. 2.

New abutment.—The construction of this abutment was suspended last fall on account of continued extreme high water, endangering the safety of the dam. Work was resumed early in July and continued until completion in October.

The following is a statement of work done:

Excavating.—Removed 937 cubic yards of stone, clay, and gravel, and 360 linear feet of old timber for foundation.

Grillage foundation.—Laid the following amount of timber:

432 linear feet	6 by 12 inches by 24 feet
308 linear feet	6 by 12 inches by 22 feet
108 linear feet	10 by 14 inches by 18 feet
210 linear feet	6 by 12 inches by 10 feet
210 linear feet	12 by 12 inches by 10 feet

Placed 116 cubic yards riprap stone in foundation; 20 cubic yards spawls and 60 cubic yards of gravel used as filling and grouting.

Dimension stone set.—Set the following amount of dimension stone in abutment:

291 linear feet quarry-face stone.....	Inches thick..	20
21 cubic yards backing stone.....	do.....	20
254 linear feet quarry-face stone.....	do.....	18
14 cubic yards backing stone.....	do.....	18
287 linear feet quarry-face stone.....	do.....	16
15 cubic yards backing stone.....	do.....	16
1,005 linear feet quarry-face stone.....	do.....	15
59 cubic yards backing stone.....	do.....	15

Return crib wall into bank above new abutment.

Excavating.—Excavated 277 cubic yards of earth, stone, and gravel, for foundation; laid as cribbing, 1,208 linear feet of hewed white oak timber; placed 1,870 feet B. M. 2-inch sheathing on face of crib; placed 75 cubic yards of riprap stone, and 75 cubic yards of clay and gravel in cribbing as filling.

Lock-keeper's dwelling.—Excavated 127 cubic yards of earth and stone for foundation; laid 97 cubic yards of dimension stone, quarry face, in the foundation; received lumber and materials for dwellings; commenced the construction of dwelling.

Lock gates.—Took out upper lock gates and removed old butterfly valves and replaced them with gridiron valves; removed old operating irons; placed new irons on all the gates; repainted gates.

Dam.—Laid 150 linear feet of new sheathing and respiked sheathing.

Dredging.—Dredged 1,875 cubic yards of material from lock pit and entrances.

General work.—Constructed protection crib above the cofferdam on the abutment side of the river; used 170 linear feet of timber and 86 cubic yards of riprap stone filling; laid 474 linear feet of timber from inside edge of new abutment at the lower end to the bank; boating and handling stone for the new abutment and lock-keeper's dwelling; rigging and setting up derricks on both sides of the river for handling material; removed 675 linear feet of timber from old abutment; constructed crib wall between old land wall and new stone abutment, used 310 lineal feet of 6 by 12 timber; quarrying and cutting stone for abutment and foundation for lock-keeper's dwelling; mixing mortar; boating sand, dimension, and riprap stone; pointing all stone work; removing cofferdam; dismantling derricks; removed 119 pieces of dimension stone from abutment side and stacked same behind lock wall; dismantling lock gates; removing drift from entrances; receiving material for new lock-keeper's dwelling; clearing Government premises of weeds; removing snow, ice, and mud from lock walls.

General remarks.—There was no suspension of navigation at this lock except for high water during the year. Lock walls were submerged by back water from the Ohio and high rises in the Kentucky rivers, 45 days. The highest water occurred March 10, lower gauge reading 45.40 feet, upper gauge 33.40 feet. The lowest water occurred September 8, lower gauge reading 6.4 feet, upper gauge 8 feet.

LOCK NO. 3.

Lock gates.—Removed five defective blocks and replaced them with new blocks; removed old operating irons and put in new improved irons; removed old butterfly valves and placed new gridiron valves; repaired wickets in filling culverts; painted lock gates.

Dam.—Removed ten defective pieces of step sheathing and replaced with new sheathing.

Lock-keeper's dwelling.—Quarried, cut, and set 112 cubic yards of dimension stone for foundation of dwelling; receiving material; framing house.

General work.—Removing drift from entrances; bolting one capstan on lock wall; cementing joints on slope wall behind the lock; made culvert in slope wall for operating irons on lock gates to work in; graded and sodded around foundation for new lock house; whitewashed and repaired fences around premises; removed drift from lock entrances, and snow, ice, and mud from lock walls.

Dredging.—Dredged 1,578 cubic yards of material from pit and entrances.

General remarks.—There was no suspension of navigation except for high water. The lock walls were submerged 17 days during the year.

The lowest water occurred October 20, lower gauge reading 6.1 feet; upper gauge reading 8.2 feet. The highest water occurred February 2, lower gauge reading 32.2 feet, upper gauge reading 21.4 feet.

LOCK NO. 4.

Lock gates.—Removed three defective blocks and put in new blocks; repaired pintle seat for lower outside gate; repaired wicket rods; painted lock gates.

Dam.—Fifty-nine pieces of defective sheathing removed and 5,310 feet B. M. oak sheathing put in; respiked step sheathing.

General work.—Regrading slope wall and cementing joints of paving; repaired lower river guide wall and bolted same to lock wall; placed 33 cubic yards of riprap stone in lower shore guide wall; repaired old gates and fences on premises; constructed water gauge at each end of slope wall; painted water gauge; rigged wire line for operating signal lights; removed snow, ice, and drift from lock walls; dismantling operating irons; removing weeds and vegetation from premises; making slight repairs on lower shore guide wall.

Dredging.—Dredged 1,325 cubic yards of material from lock pit and entrances.

General remarks.—There was no suspension of navigation except for high water. The lock walls were submerged by high water in the Kentucky River 13 days during the year.

The lowest water occurred October 20, lower gauge reading 5.6 feet, upper gauge 6.4 feet. The highest water occurred March 9, lower gauge reading 41.5 feet, upper gauge 28 feet.

LOCK NO. 5.

Dam.—One hundred and fifty feet from the abutment the dam had settled 15 inches, the settlement extending from abutment to lock wall, decreasing from settlement of 15 inches uniformly to one-half inch at both abutment and lock walls. This was leveled by putting on a new comb stick and resheathing upper slope of dam 6 feet on its face the entire length of the dam; spiked, 13,091 feet, B. M., 3-inch oak sheathing on upper slope; spiked 5,874 feet B. M. oak timber on comb of dam.

Lock-keeper's dwelling.—Quarried, cut, and set 120 cubic yards of stone for foundation of new house, receiving material and constructing house by hired labor; dwelling completed with the exception of painting and a small amount of plastering.

Dredging.—Dredged 1,125 cubic yards of material from lock pit and entrances.

General work.—Constructed 1,800 linear feet of fence around Government premises; removed drift from entrances; dismantled operating irons; beveled 7,240 linear feet of timber for repairing dam; bored 1,007 4-inch holes for spiking timber and sheathing on dam; whitewashed and repaired old lock-keeper's dwelling; quarrying stone and excavating for foundation of new dwelling; hauled stone and sand for foundation; mixing mortar; carrying water; building fence on abutment side of river; resetting 46 fence posts; removing snow, ice, and mud from lock walls.

General remarks.—There was no suspension of navigation at this lock, except from high water, during the year. The lock walls were submerged 9 days.

The lowest water occurred October 18, lower gauge reading 5.70 feet, upper gauge 8.10 feet. The highest water occurred March 10, lower gauge reading 40.70 feet, upper gauge 29.30 feet.

UNITED STATES SNAG BOAT KENTUCKY.

The snag boat has been engaged in making repairs to the locks, doing necessary snagging, and acting as tender to dredge boat.

The following is a statement of work done:

Towed the following amount of stone: 377 cubic yards of dimension stone from Lock No. 6 to Lock No. 2; 153 cubic yards of riprap stone from Drennon to Lock No. 2; 193 cubic yards of paving-stone from Lock No. 6 to Lock No. 1; 910 cubic yards of paving stone from Drennon to Lock No. 1; 147 cubic yards from Stony Creek to Lock No. 1; 150,000 (estimated) feet B. M. lumber loaded on barges at Frankfort and towed to Lock No. 6; removed 59 snags and 1 wreck (coal barge) at Lock No. 2; worked 23 days on new hull for dredge boat; assisted in putting in new valves at Locks Nos. 1 and 2; worked 9 days at Lock No. 6, pumping, hoisting timbers, etc.; miles run from July 1, 1890, to June 30, 1891, 6,575.

UNITED STATES DREDGE BOAT WILLIE.

Completed building house over machinery and cabin for crew.

The following is a statement of work done at the locks:

Lock No. 1	cubic yards dredged	2, 155
Lock No. 2	do	1, 875
Lock No. 3	do	1, 578
Lock No. 4	do	1, 325
Lock No. 5	do	1, 125
Total		8, 058

UNITED STATES DERRICK BOAT.

The derrick boat has been engaged in making repairs at the locks, hoisting stone and timber, loading and unloading barges, and driving piles.

It assisted in the construction of the new abutment at Lock No. 2, handling material for cofferdam, and dimension and riprap stone for abutment.

Respectfully submitted.

R. S. BURNETT,
Assistant Engineer.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

Report of lockages on Kentucky River, Kentucky, for fiscal year ending June 30, 1891.

Locks.	Days operated.	Days suspended.	Going up.			Going down.			Total crafts and flats passing locks.	Total number of lockages.
			Steam-boats.	Barges and flats.	Miscellaneous.	Steam-boats.	Barges and flats.	Rafts.		
No. 1.....	275	90	426	159	75	424	137	224	1,514	1,081
No. 2.....	320	45	408	145	168	398	134	167	1,619	1,434
No. 3.....	348	17	344	134	108	340	128	81	1,280	1,136
No. 4.....	352	13	312	136	97	304	121	162	1,265	1,106
No. 5.....	356	9	127	53	190	123	48	1,527	2,278	1,618
Total.....			1,617	627	636	1,589	568	2,161	7,926	6,875

List of stern-wheel boats plying on Lower Kentucky River, Kentucky.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	
U. S. snag boat Kentucky.....	Snag boat.....	136.6	30	4.6	830
Lancaster.....	Packet.....	135.6	26.5	3.8	156.00
Hibernia.....	do.....	135	25	4	157.06
Falls City.....	do.....	132.5	27	4.4	223.35
Bob Ballard.....	do.....	130	26.2	4	150.83
City of Clarksville.....	do.....	126	26	3.6	194
John Barrett.....	do.....	124.8	31	5.5	187.23
Hattie Brown.....	do.....	120	20	3	58.11
Bellvue.....	do.....	120	24	3.6	89.23
Blue Wing.....	do.....	119	24	4	111.82
Grace Morris.....	do.....	100	20	3	78.88
T. D. Dale.....	do.....	111.6	19	3.2	79.89
Little Sandy.....	do.....	94	16	3	39.34
Ghent*.....	do.....	58	10	4	4.85
Florence*.....	do.....	48	11.5	4	4.08
Dolphin*.....	do.....	48	11.5	4	4.08
Mazy.....	do.....	37	7.4	2.8	8.31
Geo. W. Stone.....	Tow.....	124	20.5	3.5	106.50
L. A. Fulton.....	do.....	122	23	3	107.99
Excel.....	do.....	122	21.5	3.5	118.90
Jessie.....	do.....	120	20	3.4	68.47
Al Martin.....	do.....	112	23.6	4	96.68
Hot Sp.....	do.....	110	22	3	89.39
Alex Montgomery.....	do.....	98	23.3	4.2	79.50
W. B. Cole.....	do.....	92.6	18.1	3.4	54.74
D. D. Baker.....	Saw mill.....	117	18.3	4.3	70.83

*Screw propeller.

J J 6.

IMPROVEMENT OF LICKING RIVER, KENTUCKY, FROM FARMERS TO WEST LIBERTY.

The project for the improvement of this river was approved by the Secretary of War under date of September 20, 1888, and provides for removal of snags, detached rocks, and bowlders from the river bed with a view to improving low-water navigation and rafting. This work can only be done to advantage during low water, and in consequence it was May 15 of the present year before it was deemed advisable to commence operations.

For details regarding this season's work attention is invited to the report of Assistant Engineer B. F. Thomas, appended hereto.

The improvement can not be regarded as permanent in consequence of the fact that the obstructions due to snags and leaning trees will continue to form.

The original estimate of the cost of the improvement was \$17,680 for that portion of the river between Farmers and West Liberty, and it is recommended that of the balance yet unappropriated \$5,000 be appropriated for the fiscal year ending June 30, 1893.

Money statement.

July 1, 1890, balance unexpended	\$132. 08
Amount appropriated by act approved September 19, 1890	3, 000. 00
	<hr/>
	3, 132. 08
June 30, 1891, amount expended during fiscal year	1, 097. 41
	<hr/>
July 1, 1891, balance unexpended	2, 034. 67
July 1, 1891, outstanding liabilities	503. 50
	<hr/>
July 1, 1891, balance available	1, 531. 17
	<hr/>
{ Amount (estimated) required for completion of existing project	11, 680. 00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	5, 000. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867	

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

LOUISA, KY., June 30, 1891.

MAJOR: Work was commenced upon Licking River on May 5, 1891, at a point 60 miles above Farmers, Ky. A large amount of loose and solid rock, as well as many snags and stumps, have been removed near Flatwoods Spring Branch, Mussel Shoals, and Turtle Island, a distance of about 10 miles. Near the latter place over 13 large bowlders have been blasted out and a large drift removed.

The following is an estimate of the work done up to date:

Excavation:	
Solid rock	cubic yards.. 5,875
Loose rock	do.... 2,145

Class of work.	Number.	Length.	Girth.
		<hr/>	<hr/>
Snags removed	79	<hr/>	<hr/>
Trees removed	27	<hr/>	<hr/>
Stumps removed	60	<hr/>	<hr/>
Trees topped	2	<hr/>	<hr/>

It is proposed to complete the expenditure of the appropriation this season by the removal of large rocks at Blackwater, Log Cabin Bend, Devil Creek, Big Laurel, Little Laurel, McClure, and Old Cow and Twin Calves.

It is proposed to remove all dangerous snags and otherwise improve the channel, and to clean out and put in good condition all the shoals on the river. After this appropriation is exhausted there will yet remain much important work to be done, but the river will be in a fairly safe condition.

Respectfully submitted.

B. F. THOMAS,
Assistant Engineer.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS FOR FISCAL YEAR ENDING JUNE 30, 1891, LICKING RIVER,
KENTUCKY.

Article.	1890.	1891.
	<i>Tons.</i>	<i>Tons.</i>
Bark	20	
Coal	912	190
Logs	33,750	20,000
Merchandise	100	12
Staves	19	70
Total	34,801	20,272

J J 7.

IMPROVEMENT OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

The Big Sandy River, which is formed by the union of the Tug and Levisa forks, flows north a distance of 26 miles and empties into the Ohio at Catlettsburg, Ky. The main river and the Tug form the boundary between Kentucky and West Virginia, and the Upper Tug, for a distance of about 18 miles, forms the boundary between Virginia and West Virginia. The Tug Fork rises in the southwest corner of West Virginia and flows northwest to its junction with the Levisa Fork, with a total length of 140 miles. The Levisa Fork rises in the southwestern part of Virginia, then entering Kentucky flows in a northerly direction. Its total length is about 189 miles.

The present approved project provides for the construction of a lock and dam on the main river near Louisa, Ky., and the clearing of the main stream and the forks of obstructions.

At the close of the last fiscal year the lock, with gates, wickets, operating machinery, etc., were completed, as well as the abutment.

The amount of money available was insufficient to build the dam, and on this account so much work only was undertaken as could be completed.

During the past year a considerable amount of grading was done about the abutment; a part of the dam next the abutment completed, and preparations made for carrying the dam through to the lock. I had a notice published that the river would be closed to navigation May 15, in order to put in the remainder of the dam, which developed a powerful opposition, primarily, against the closure of navigation, but which took the form of a general opposition to a fixed dam. The matter is now before a Board of Engineers, of which I am a member. In

advance of the final report of the Board, I do not deem it proper to discuss the subject of the character of dam at this locality.

A contract is in force with Marting, Mittendorf, and Duis, of Kilgore, for furnishing the timber for the dam, and the delivery is going on. The money available is sufficient to complete the dam and open the lock for navigation. A change to a movable dam will, as a matter of course, increase the estimate of the cost of completion, besides necessitating radical changes in the lock.

For details of work done during the past year, attention is invited to the report of Assistant Engineer B. F. Thomas, herewith.

Money statement.

July 1, 1890, balance unexpended	\$15,202.64
Amount appropriated by act approved September 19, 1890	31,000.00
	46,202.64
June 30, 1891, amount expended during fiscal year	16,468.49
July 1, 1891, balance unexpended.....	29,734.15
July 1, 1891, outstanding liabilities	\$2,273.15
July 1, 1891, amount covered by uncompleted contracts.....	6,946.06
	9,219.21
July 1, 1891, balance available.....	20,514.94

Abstract of bids received and opened January 5, 1891, by Maj. D. W. Lockwood, Corps of Engineers, for oak timber for dam, Big Sandy River, West Virginia and Kentucky.

No.	Name and address of bidder.	Hard-wood timber, flat- ted, 12 by 8 inches, 15,002 linear feet.	Oak timber.				Total.
			Squared, 10 by 10 inches, 169,999 feet, B. M.	Decking, 9 by 12 inches, 178,290 feet B. M.	Sheeting, 3 by 12 inches and 2 by 12 inches, 27,040 feet, B. M.		
		<i>Per lin. ft.</i>	<i>Per M.</i>	<i>Per M.</i>	<i>Per M.</i>		
1	Valentine J. Drayer, Iron- ton, Ohio.....	\$0.30	\$35.00	\$50.00	\$20.00	\$20,101.36	
2	Henry A. Marting, Adam Mittendorf, Fred Duis, Kilgore, Ky.....	.16	20.00	25.00	19.50	10,977.58	
3	John H. Bedell, Vance- burg, Ky.....	.18	24.90	24.90	24.90	12,292.81	

The bid of Messrs. Marting, Mittendorf, and Duis was accepted.

Abstract of bids received and opened February 10, 1891, by Maj. D. W. Lockwood, Corps of Engineers, for iron for construction of dam on Big Sandy River, West Virginia and Kentucky.

No.	Name and address of bidder.	Drift bolts, 36,000 pounds.	Bolt ends, 180 pounds.	Iron, 8,100 pounds.	Total.
		<i>Per lb.</i>	<i>Per lb.</i>	<i>Per lb.</i>	
1	George Kinsey & Co, Cincinnati, Ohio.....	\$0.02 $\frac{1}{4}$	\$0.03 $\frac{1}{4}$	\$0.01 $\frac{1}{4}$	\$863.44
2	Pattin, Hall & Pattin, Marietta, Ohio.....	.04	.04 $\frac{1}{2}$	.03 $\frac{1}{2}$	1,710.90

The bid of Messrs. George Kinsey & Co. was accepted.

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

LOUISA, KY., June 30, 1891.

MAJOR: The annual report upon Big Sandy River for fiscal year ending June 30, 1891, is herewith respectfully submitted.

At the close of last year the abutment and the lock, including the gates, wickets, etc., had been completed. During the year just ended work has been continued on the blasting out of the lower lock approach, and was begun upon the dam, and about 90 feet of cribs put in and filled with riprap, and 22 feet of the dam was entirely finished.

The river bank below the abutment has been graded preparatory to paving. A chute about 500 feet long was cut next the lock for the passage of boats during the completion of the dam. The whole of the drift bolts and about one-third of the crib timber and decking are now on the ground.

In reply to a circular letter from this office dated September 19, 1890, proposals for part of the sawed timber for the dam was received and opened on September 29, 1890, and the contract was awarded to V. J. Drayer, of Gallup, Ky. Delivery under this contract, amounting to 73,197 B. M. feet, has been completed. J. B. Peters also delivered 1,408 linear feet of flatted timber contracted for October 3, 1889.

Besides the completion of the dam the following remains to be done: Building guide cribs; completion of excavation of lower approach; building lock-keeper's dwelling, and protection of banks by walls and paving.

A detailed statement of work done and cost of labor is as follows:

Work.	Amount.	Cost.	Remarks.
Stone put in dam..... cubic yards..	2, 878	\$1, 068. 60	End next abutment.
Excavation:			
Earth..... do.....	13, 503	2, 279. 90	Approaches, dam, bank below abutment.
Solid rock..... do.....	1, 987	1, 280. 10	Lower approach.
Loose rock..... do.....	925	283. 76	Chute next lock.
Riprap..... do.....	567	181. 29	Bank below abutment.
Timber put in dam..... ft. B. M.	51, 415	309. 32	Dam next abutment.
Sheet piles put in dam..... do.....	16, 320	174. 00	Dam next abutment and lock.
Piles driven..... linear feet..	1, 360	244. 00	Do.
Derries made..... number..	3	33. 10	General use.
Total		5, 854. 05	

Very respectfully,

B. F. THOMAS,
Assistant Engineer.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS FOR FISCAL YEAR ENDING JUNE 30, 1891, BIG SANDY RIVER,
WEST VIRGINIA AND KENTUCKY.

Articles.	1890.	1891.	Articles.	1890.	1891.
	<i>Tons.</i>	<i>Tons.</i>		<i>Tons.</i>	<i>Tons.</i>
Hides.....	75	50	Timber, logs, knots, etc.....	208, 491	225, 000
Leather.....	34	30	Ties, railroad.....	15, 000	10, 000
Lumber.....	3, 000	3, 000	Wheat.....	510	489
Produce.....	2, 511	3, 000	Wool.....	11	15
Live stock.....	495	500	Miscellaneous.....	19, 000	21, 069
Spokes.....	750	2, 200	Passengers.....	1, 874	900
Slaves.....	7, 000	1, 050			
Tan bark.....	9, 831	10, 000	Total	318, 582	277, 303

List of boats plying on Big Sandy River, West Virginia and Kentucky.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	
Ed. C. Kirker (tow).....	Side wheel..	73	8	3	7
Sip Bayes	do	100	14	1.8	24.12
Sandy Valley	do	105	14	2.8	40
Virgie Ratliff	do	110	15	2.6	43
Ida Smith	Stern wheel.	100	16	3	45
Mary L. Hatcher	do	110.4	20	3	55.06
Lexington	do	120	22	3.5	58.72
Frank Preston	do	110	18	3	60
Andy Hatcher	do	117	18	3	65
J. C. Hopkins	Side wheel..	102.5	16.4	2.4	67
S. R. Vanmetre (tow).....	Stern wheel.	112	18.3	3.4	98.5
Tom Spurlock	do	117	22	3	100

An increase of 5 boats over 1890.

J J 8.

IMPROVEMENT OF LEVISA FORK OF BIG SANDY RIVER, KENTUCKY.

The Levisa is the western of the two forks that unite at Louisa to form the Big Sandy River. It rises in the southwestern part of Virginia, at an elevation of about 1,500 feet above tide water, and flows in a northerly direction. Its banks in many cases are rocky, in others composed of sand and clay. It possesses all the characteristics of a mountain stream, a steep average slope, and pools of varying depth, separated by rocky bars or ripples that at low water often have but a few inches of water over them. The average fall from Pikeville to Louisa is 1.49 feet per mile, the distance being 86½ miles.

The object of the improvement has been to facilitate rafting and push-boat navigation in the upper river and to improve low-water steamboat navigation so far as this can be done. Steamboats can not run in this or Tug Fork at dead low water, but the work done so far has been of such a character as to permit of their running on smaller rises than was the case before the improvement was commenced.

Coal mines have been opened at and near Peach Orchard and quite extensive shipments are made by rail to Ashland, on the Ohio, where it is put in barges for transportation down that river. Could coal be shipped out by water from the mines, the output of coal would be largely increased.

The work done has consisted of removing from the channel rocks, bowlders, snags, logs, stumps, etc., and from the banks of the river, overhanging trees that interfered with steamboats.

The stream under the present project is incapable of permanent improvement, as the obstructions to navigation, such as snags, stumps, logs, etc., are liable to reform at any time, and an annual appropriation of about \$2,500 is needed to keep it clear.

For details concerning the work done during the past fiscal year attention is invited to the report of Assistant Engineer B. F. Thomas, appended hereto.

Money statement.

Amount appropriated by act approved September 19, 1890.....	\$2,500.00
June 30, 1891, amount expended during fiscal year	1,348.24
July 1, 1891, balance unexpended.....	1,151.76
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	2,500.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

LOUISA, Ky., June 30, 1891.

MAJOR: Work was begun upon the Levisa Fork of Big Sandy River about the 1st of November and continued until about Christmas, when cold weather stopped the work. It will be resumed when the water is sufficiently low to work to advantage. The principal work done was the cleaning out of shoals, particularly, White House, Greasy, Wireman, Sugar Loaf, Hawes Ford, Grimes, Sayer Milldam, and Abbott. Snags were taken out at Prestensburg, Mud Creek, and many other places, and a wing dam to throw the water into the chute was built at Layne Dam.

The distance worked over was 82½ miles. A summary of work done forms part of this report and reference to it is made for quantities and cost of work done. An appropriation should be made to maintain the old work and continue the improvement.

The work has been continued under the charge of Mr. Fred. McHenry, overseer, assisted by Mr. James Welch, a river pilot.

Summary of work done on Levisa Fork during year ending June 30, 1891.

Work.	Number.	Length.	Girth.
		<i>Feet.</i>	<i>Feet.</i>
Snags removed.....	259	25	5.5
Trees removed.....	129	75	6.6
Stumps removed.....	174		
<hr/>			
Solid rock removed.....		Cubic yards..	230
Loose rock removed.....		do.....	1,523

Respectfully submitted.

B. F. THOMAS,
Assistant Engineer.Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

J J 9.

IMPROVEMENT OF TUG FORK OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

The Tug Fork is the eastern of the two forks which unite at the town of Louisa, 26 miles from the Ohio, to form the Big Sandy River. It rises in the southwest corner of West Virginia and flows toward the northwest for a distance of 140 miles. For a distance of 18 miles at its head it forms a part of the boundary between Virginia and West Virginia, and below this it and the Big Sandy form the boundary between West Virginia and Kentucky.

The Tug throughout most of its length is a characteristic mountain stream formed of a series of pools separated by ripples.

The average fall per mile from Pond to Warfield, a distance of 23.5 miles, is 1.96 feet per mile, and from Warfield to Louisa, a distance of 35 miles, 1.72 feet per mile.

The object of the improvement has been to facilitate rafting of logs from the upper portion of the stream and its branches, to provide a low-water push-boat channel, and to make it possible for light draft steamboats to run at lower stages than formerly while the river was in an unimproved state.

The work done has been that of clearing the channel of rocks, snags, stumps, etc., and the banks of overhanging trees, while with special

reference to the push-boat interests, channels have been cut through the ripples or shoals.

The Norfolk and Western Railroad people have seriously interfered with push-boat navigation and rafting in the upper river by cutting trees and blasting rock into the channel.

An injunction was gotten out against them in the United States court at Louisville, Ky., to prevent further injury to the stream, and a suit instituted to effect the removal of obstructions already created.

I do not know what the legal situation is at present. I have written the United States attorney at Louisville for information on the subject without receiving an answer.

This stream is incapable of permanent improvement, as the obstructions formed by logs, snags, etc., are liable to reform at any time, and a small annual appropriation is needed to keep it free. For details concerning the work done during the past fiscal year attention is invited to the report of Assistant Engineer B. F. Thomas, appended hereto.

Money statement.

Amount appropriated by act approved September 19, 1890.....	\$2,500. 00
June 30, 1891, amount expended during fiscal year.....	1,078. 33
July 1, 1891, balance unexpended.....	1,421. 67
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	2,500. 00
{ Submitted in compliance with requirements of sections 2 of river and	
{ harbor acts of 1866 and 1867.	

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

LOUISA, KY., *June 30, 1891.*

MAJOR: The report of work done upon the Tug Fork of Big Sandy River for the fiscal year ending June 30 is respectfully submitted:

Work was not begun until the 10th of November on account of the late date at which money became available. The boats were pushed to Sycamore, 61 miles above Louisa, and then work was begun downstream. In previous years the work has been confined largely to the bed of the river, the shoals, snags, rocks, etc., but little attention has been given to overhanging trees, and on this account it was thought best to expend the present appropriation almost entirely for this manner of improvement, so as to assist the larger steamboats in ascending and descending the stream. The previous improvements have been more with a view to secure good push-boat and raft navigation rather than for steamboats, but the latter have found so much to do in the stream since the Government has made it safe to go into it, that now all the navigation companies plying on the main river as well as a regular tug line have put their boats into the trade.

The Norfolk and Western Railroad Company are building an extension of their line along the upper part of Tug River, and make two crossings upon the part improved by the United States. They have cut a great many trees and blasted large rocks into the channel and have greatly interfered with push-boat navigation and the running of timber, both in rafts and loose logs.

Complaints have been received from many points along this river of the killing of fish by the use of dynamite. It has become general throughout this district on all the rivers, and the State laws don't seem competent to handle the matter. I think the United States should speedily enact a law which would stop this wanton destruction of the fish in its waters; otherwise, in a very few years, there will be none left. In some sections they may be seen by the hundreds floating dead upon the water, the explosion having killed more than were needed by the parties handling the explosive. Dynamite not only kills the larger and marketable fish, but it also destroys the small ones, which are at present of no use to anyone.

Owing to cold weather, the work was suspended December 20, and will be resumed again as soon as the water is at a low enough stage to get at the channel obstructions.

A detailed statement of the work done is as follows:

Excavation:	
Solid rock	cubic yards.. 36.5
Loose rock	do..... 42.7

Work.	Number.	Length.	Girth.
		<i>Feet.</i>	<i>Feet.</i>
Snags removed.....	463	17.8	4.2
Trees removed	306	40.0	5.2
Trees topped.....	184		
Stumps removed	136	14.3	6.9

I would respectfully recommend further improvement of the river by the removal of obstructions in the channel, the cleaning of the shoals, and the cutting of overhanging timber.

The river is rapidly becoming one of importance, and I think should be kept in good condition for steamboats as well as for the use of push boats and rafts.

The work has been done under the direction of Mr. A. Lee Barret, of Warfield, Ky.
Respectfully submitted.

B. F. THOMAS,
Assistant Engineer.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

J J 10.

IMPROVEMENT OF GUYANDOTTE RIVER, WEST VIRGINIA.

The Guyandotte River rises in the southwestern part of West Virginia and, flowing in a northwesterly direction, empties into the Ohio 12 miles above the mouth of the Big Sandy, and 39 miles below the mouth of the Great Kanawha.

The project for the improvement was adopted in 1878, and contemplated the obtaining of a clear channel with a width of 30 feet and a least depth of 18 inches during 5 months of the year, by the removal of rocks, snags, and other obstructions. This river was practically closed before work commenced except during rises of considerable height.

The stream was once improved by the State of Virginia by the construction of six locks and dams. The locks were constructed of timber, and, as a matter of course, after a time, the charges for repairs, rendered necessary by the natural decay of the wood, became very great, and a little further along the system was abandoned, and what had formerly constituted a useful improvement now became obstructions. The old locks and dams were carried away in part after a little by floods, so that when the first report on this river was made by Maj. William E. Merrill, in 1875, most of them had been washed away, but the ruins of one still constituted the worst obstruction on the river.

There are two milldams, Peck's, 7 miles below Logan, and Lambert's, 19 miles below Peck's, that still constitute serious obstructions to navigation and have been reported to the Department as such. The authority for their construction in the first place was based upon a permit from the circuit court, and their continuance has been a nuisance and constant damage to the river interests.

The work in previous years has been to cut passage ways through the

2470 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

old dams where required, make channels through the shoals for push boats and remove obstructions such as rocks, snags, stumps, logs, etc., existing in the channel of the river as would interfere with rafting at ordinary and low rafting stages. During the past year the work done has been above Logan, with a view to assisting the running of rafts. The stream is incapable of permanent improvement, as the obstructions in the channel such as trees, snags, logs, etc., are liable to reform. The stream up to Logan, a distance of $81\frac{1}{2}$ miles, has an average fall of about 22 inches to the mile.

For details concerning the work, attention is invited to the report of Assistant Engineer B. F. Thomas, attached hereto.

Money statement.

July 1, 1890, balance unexpended	\$126.55
Amount appropriated by act approved September 19, 1890.....	2,000.00
	<hr/>
	2,126.55
June 30, 1891, amount expended during fiscal year.....	729.55
	<hr/>
July 1, 1891, balance unexpended	1,397.00
July 1, 1891, outstanding liabilities	415.70
	<hr/>
July 1, 1891, balance available	981.30
	<hr/>
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	5,000.00
{ Submitted in compliance with requirements of sections 2 of river and	
{ harbor acts of 1866 and 1867.	

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

LOUISA, KY., June 30, 1891.

MAJOR: I have the honor to submit herewith my annual report upon the Guyandotte River improvement.

Work was commenced on May 21, 1891, a few miles above Logan.

One rock bar has been removed near Big Creek, as well as a drift of some 300 logs, while a large amount of loose rock has been taken out near the shoal at the mouth of Big Huff Creek, so as to widen the chute.

The present appropriation will be expended in the improvement of that part of the river lying below Logan, particularly with a view to assist the running of timber rafts and loose logs. There are several dams in the lower part of the river which, if removed, would enable steamboats to navigate all that part of the stream during the winter and spring months, and would greatly benefit that country.

It is respectfully recommended that sufficient money be appropriated for the purchase and removal of these dams as well as for continuing the improvement of the upper part of the river.

Respectfully submitted.

B. F. THOMAS,
Assistant Engineer.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS FOR FISCAL YEAR ENDING JUNE 30, 1891, GUYANDOTTE RIVER, WEST VIRGINIA.

	Tons.
Timber	60,000
Miscellaneous	1,128

JJ II.

IMPROVEMENT OF LITTLE KANAWHA RIVER, WEST VIRGINIA.

The Little Kanawha drains the central portion of West Virginia, rising in Upshur County; its course is a little north of west, and it empties into the Ohio at Parkersburg; its total length is about 150 miles.

The Little Kanawha Navigation Company owns and operates four locks and dams on this river, which furnish slackwater navigation from the Ohio up to a point 2 miles above the village of Burning Springs, where the United States lock is located, but the service of this system is very poor, owing to the dilapidated condition of both locks and dams; breaks and washouts are of frequent occurrence during high water, and the interruptions to navigation in consequence expensive and harassing.

The present project for the improvement of this river, adopted in 1876 and modified in 1880, contemplates the construction of a lock and dam to extend slackwater navigation for a draft of 4 feet a distance of 12 miles above the point reached by the Navigation Company, and the improvement of the natural channel of the upper river by the removal of obstructions, etc., for a distance of 80 miles, the object of the latter being to obtain a channel of a minimum width of 40 feet with a depth of 2 feet for at least 4 months in each year.

The work of the past season has consisted of building the abutment, quarrying and transporting stone for the dam, framing timber for lock gates, and filling in behind the land wall of lock.

A contract is in force with T. W. Moore, of Marietta, for furnishing timber for dam.

It is expected that the balance available will complete the dam and open the lock for navigation.

No work has been done on the upper river.

For details concerning the work done during the past year, attention is respectfully invited to the report of Assistant Engineer B. F. Thomas, appended hereto.

Money statement.

July 1, 1890, balance unexpended	\$1, 029. 04
Amount appropriated by act approved September 19, 1890	40, 000. 00
	<hr/>
June 30, 1891, amount expended during fiscal year	41, 029. 04
	13, 713. 75
	<hr/>
July 1, 1891, balance unexpended	27, 315. 29
July 1, 1891, outstanding liabilities	\$1, 561. 26
July 1, 1891, amount covered by uncompleted contracts	3, 848. 03
	<hr/>
	5, 409. 29
	<hr/>
July 1, 1891, balance available	21, 906. 00

2472 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of bids received and opened January 5, 1891, by Major D. W. Lockwood, Corps of Engineers, for oak timber for dam, Little Kanawha River, West Virginia.

No.	Name and address of bidder.	Oak timber.			Total.
		Squared 10 by 10 in- ches (210,141 feet, B. M.).	Decking, 9 by 12 in- ches (115,300 feet, B. M.).	Sheeting, 3 by 12 in- ches (20,040 feet, B. M.).	
1	Alex. J. Mitchell, Josiah H. Fortney, Burning Springs, W. Va.	<i>Per M.</i> \$21.00	<i>Per M.</i> \$22.00	<i>Per M.</i> \$18.00	\$7,205.98
2	Marcellus Hardman, Orlando Hardman, Allen Hardman, Grantville, W. Va.	33.00	33.00	33.00	11,394.27
3	John A. Rathbone, Ready Ripple, W. Va.	25.00	21.00	21.00	8,091.06
4	John H. Bedell, Vanceburg, Lewis County, Ky. .	24.50	24.50	24.50	8,456.38
5	Thomas W. Moore, Marietta, Ohio	18.75	18.00	16.00	6,332.50

The bid of Thomas W. Moore was accepted.

Abstract of bids received and opened January 26, 1891, by Major D. W. Lockwood, Corps of Engineers, for ironwork for gates of Lock No. 5, Little Kanawha River, West Virginia.

No.	Name and address of bidder.	Cast iron, 23,673 pounds.	Wrought iron, 23,914 pounds.	Steel, 44 pounds.	Total.
1	Lambert Bros. & Co., Ironton, Ohio	<i>Per pound.</i> \$0.07 $\frac{1}{2}$	<i>Per pound.</i> \$0.06 $\frac{1}{2}$	<i>Per pound.</i> \$0.15	\$3,496.87
2	Pattin, Hall & Pattin, Marietta, Ohio .....	.04	.04 $\frac{1}{2}$	.05	2,118.98

The bid of Messrs. Pattin, Hall & Pattin was accepted.

Abstract of bids received and opened February 10, 1891, by Major D. W. Lockwood, Corps of Engineers, for iron for construction of dam on Little Kanawha River, West Virginia.

No.	Name and address of bidder.	Drift bolts, 20,500 pounds.	S. & W. bolts, 1,600 pounds.	Round iron, 5,000 pounds.	Boatspikes, 3,000 pounds.	Total.
1	Parkersburg Hardware and Manu- facturing Co., Chas. B. Smith & Co. (headed)	<i>Per pound.</i> \$0.03 $\frac{1}{2}$	<i>Per pound.</i> B. \$0.03 $\frac{1}{2}$ W. 0.02 $\frac{1}{2}$	<i>Per pound.</i> \$0.03 $\frac{1}{2}$	<i>Per pound.</i> \$0.03 $\frac{1}{2}$	\$957.53
	Parkersburg, W. Va. (not headed) . . .	0.03 $\frac{1}{2}$	0.04 $\frac{1}{2}$	0.03	0.04	629.50
2	Pattin, Hall & Pattin, Marietta, Ohio	0.03 $\frac{1}{2}$	0.04 $\frac{1}{2}$	0.03	0.04	1,084.00
3	Geo. Kinsey & Co., Cincinnati, Ohio..	0.02 $\frac{1}{2}$	0.02 $\frac{1}{2}$	0.02	0.02 $\frac{1}{2}$	684.95

The bid of Messrs. Geo. Kinsey & Co. was accepted.

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

LOUISA, KY., June 30, 1891.

MAJOR: I have the honor to report upon the work being done by the Government at Lock No. 5, Little Kanawha River, for the fiscal year ending to-day.

Owing to the lateness of the season when the new appropriation became available, work was not begun until February of this year, when stonecutting for the abutment was resumed. The abutment has been completed and the wing walls counterforts of the lock have been extended into the bank, so that all masonry is now complete.

The quarrying of stone was begun early in the year for the dam and guide cribs

and has been about completed. The quarry is located a short half-mile below the lock, on the land of Col. T. W. Moore.

The river had been well cleaned between lock and quarry, so that the boating of stone can be done with speed and safety. The framing of the lock gates has been completed and the gates are now being put in place.

Work upon the dam was begun the first week in June, but owing to rises in the river the first crib, 50 by 100 feet, was floated into quiet water for safety. It was taken back to its right position on the 15th and properly sunk and partly filled with stone, when another rise stopped work upon it for a few days.

Owing to the slips in the bank behind land wall of lock, caused by the wet weather during its construction in 1889, a large amount of earth had to be removed. This has now been replaced and is ready for the paving.

The work yet to be done is the completion of dam, paving and protecting banks, construction of guide cribs, protection of river-wall foundation below dam by the construction of cribs, protection of bank behind abutment by crib and riprap work, and excavation of approaches to lock.

For a better understanding of the details of the work done, reference is had to the following:

Statement of work done at Lock No. 5, Little Kanawha River, West Virginia, during the year ending June 30, 1891.

Work.	Amount.	Cost.	Remarks.
Stone cut.....cu. yds..	129.93	\$242.07	For abutment.
Stone laid.....do.....	550	363.22	In abutment and wing walls of lock.
Stone quarried.....do.....	4,029	1,090.11	For filling cribs of dam.
Excavation earth.....do.....	1,149	233.90	For abutment, lock wing walls, dam, etc.
Embankment earth.....do.....	5,587	1,141.87	Behind land wall of lock.
Timber put in gates.....ft. B. M.	12,897	323.10	
Timber put in dam.....do.....	36,830	100	
Stone put in dam.....cu. yds..	508	211.40	
Miscellaneous work.....do.....		2,030.23	
Total cost of labor.....do.....		5,770.90	

The work has been in local charge of J. C. Thomas, assistant engineer.

Respectfully submitted.

B. F. THOMAS,
Assistant Engineer.

Maj. D. W. LOCKWOOD,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS FOR FISCAL YEAR ENDING JUNE 30, 1891, LITTLE KANAWHA RIVER, WEST VIRGINIA.

Articles.	1890.	1891.	Articles.	1890.	1891.
	<i>Tons.</i>	<i>Tons.</i>		<i>Tons.</i>	<i>Tons.</i>
Coal.....	1,100	10,507	Ties, railroad.....	27,650	43,312
Lumber.....	8,540	23,677	Passengers.....	1,563	1,500
Oil.....	678	1,450	Miscellaneous.....	5,084	13,575
Staves.....	24,500	26,964			
Timber.....	70,000	59,703		140,115	190,688

List of steamboats plying on Little Kanawha River, West Virginia.

Name of boat.	Stern or side wheel.	Length.	Breadth.	Depth.	Tonnage.
		<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	
J. King, tow.....	Stern.....	66½		3	34.93
Mary E., tow.....	do.....	86	13½	3½	
W. A. Hilton, packet.....	do.....	105	22	3½	67.54
Oneida, packet.....	do.....	104	19½	4½	75.78
Lulu F., packet.....					
Watson, tow.....					

J J 12.

IMPROVEMENT OF BUCKHANNON RIVER, WEST VIRGINIA.

The project for the improvement of this stream, approved in 1884, is to clear out that portion of the river between the Three Forks and the town of Buckhannon, a distance of 24½ miles. The obstructions consist of log jams and boulders, some of which are estimated to contain 500 cubic yards.

The project called for a channel 30 feet wide.

Buckhannon River is a tributary of the Tygart Valley, and, rising in the southwestern part of Randolph County, W. Va., flows a little east of north until it empties in the Tygart Valley River, in Barbour County.

The distance from the Three Forks to the mouth is 47½ miles, and the total length of the stream is about 57 miles.

No work was done during the past fiscal year, but when the river has reached a very low stage it is proposed to expend the balance in improving some of the worst places.

The object of the improvement was to render rafting of logs possible at a less stage of water than was required when the river was in its natural state.

A railroad has now been completed along the river bank extending up to the timber country, and but few logs were floated down last year. This being the case, it does not seem advisable that any additional work, beyond that which can be done with the present balance, should be done towards improving the river, more especially as the improvement, when completed, would only afford opportunities for rafting during a few months of each year. No additional appropriation is recommended.

Money statement.

July 1, 1890, balance unexpended.....	\$44.40
Amount appropriated by act approved September 19, 1890	1,000.00
	1,044.40
June 30, 1891, amount unexpended during fiscal year.....	17.00
July 1, 1891, balance unexpended.....	1,027.40

J J 13.

PRELIMINARY EXAMINATION OF BIG BARREN RIVER, KENTUCKY,
ABOVE BOWLING GREEN, WITH A VIEW OF EXTENDING SLACK-
WATER NAVIGATION BY ADDITIONAL LOCKS AND DAMS.

[Printed in House Ex. Doc. No. 15, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1890.

SIR: I have the honor to submit herewith the accompanying copy of report dated November 11, 1890, from Maj. D. W. Lockwood, Corps of Engineers, giving results of preliminary examination of Big Barren River, Kentucky, above Bowling Green, with a view of extending slackwater navigation by additional locks and dams, made to comply with provisions of the river and harbor act approved September 19, 1890.

Major Lockwood reports that Big Barren River is not worthy of improvement by additional locks and dams above Bowling Green. This opinion is concurred in by Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division, and by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF MAJOR D. W. LOCKWOOD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, November 11, 1890.

SIR: I have the honor to submit the following report of a preliminary examination of "Big Barren River, Kentucky, above Bowling Green, with a view of extending slack-water navigation by additional locks and dams."

The Big Barren is a tributary of Green River, Kentucky, and enters it at a point 145½ miles above its mouth in the Ohio. The pool formed by the dam at Lock No. 4 on Green River carries slack-water navigation up the Big Barren to Greencastle, a distance of about 15 miles, and here are situated Lock and Dam No. 1, extending slack-water navigation to a point 4 miles above Bowling Green Landing.

In 1880, Lieutenant-Colonel Merrill reported on the location of two locks and dams for this river to extend slack-water navigation above Bowling Green. The assistant engineer who made the survey did not locate the first lock of the extension at the present head of pool water, but 4½ miles below, or one-half mile below the landing. The second lock of the extension, or No. 3, of the system was located above Drake Creek and about 14 miles above the Bowling Green landing.

As stated in the report of First Lieut. William L. Sibert, Corps of Engineers, herewith, should a lock and dam be built at Underwood Ferry, as recommended by Assistant Engineer Fitzhugh, who made the survey for Lieutenant-Colonel Merrill in 1879 (see Report of Chief of Engineers, U. S. Army, 1880, pages 1802 to 1822, inclusive), 10 miles of the resulting pool of 14 miles would be used up in carrying slack-water navigation to another point in Bowling Green, one-half mile from the present landing, so that the upper lock and dam would be only about 4 miles above Bowling Green.

The stream above Bowling Green is narrow and crooked, and the extent of country that would be reached by an extension of the present slack-water system is, in my opinion, too limited to warrant such an expenditure of money as the construction of two additional locks and dams would necessitate. Lieutenant Sibert states that the extension would be through an agricultural country, and that the "further improvement would not open up sufficient business to justify a steamboat in making regular trips up the stream from Bowling Green."

In view of all the circumstances, and giving full weight to every consideration concerning what the commerce of this section may become in the future, I am convinced that the river is not worthy of improvement by additional locks and dams above Bowling Green.

2476 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

The report of First Lieut. William L. Sibert, Corps of Engineers, who made the examination, is respectfully submitted herewith.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer,
Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, November 12, 1890.

Respectfully forwarded.

I concur in the opinion expressed by Major Lockwood.

O. M. POE,
*Colonel, Corps of Engineers,
Engineer, Northwest Division.*

REPORT OF LIEUTENANT WILLIAM L. SIBERT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Bowling Green, Ky., November 9, 1890.

SIR: In accordance with your verbal directions, I made an examination of Barren River, Kentucky, as far up that stream as the point selected for Lock No. 3, in a survey made in 1880, under the direction of Maj. (now Lieut. Col.) William E. Merrill, Corps of Engineers, U. S. Army. The sites selected for locks in the survey referred to above seem to be the best so far as I could judge from a mere examination.

A lock constructed at Underwood's old ferry, about one-half mile below the present boat landing, would give navigation to a point selected for Lock No. 3, just above the mouth of Drake Creek, a distance of 14 miles. Commencing at the present boat landing and going upstream the direction of the river is northeast, then it turns and the direction is southwest coming back to the foot of State street in Bowling Green, one-half mile from the boat landing, while it is 10 miles around. So 10 miles of the 14 in the first pool above the present slack water would simply give navigation around this bend to another street in Bowling Green. The Barren River is a small, crooked stream, running through an agricultural country only, and its further improvement would not, in my opinion, open up sufficient business to justify a steamboat in making regular trips up the stream from Bowling Green, and as a consequence the river is unworthy of improvement.

Very respectfully, your obedient servant,

WM. L. SIBERT,
First Lieut. of Engineers.

Maj. D. W. LOCKWOOD,
Corps of Engineers.

J J 14.

PRELIMINARY EXAMINATION OF RUSSEL FORK OF THE BIG SANDY RIVER, KENTUCKY, WITH THE VIEW OF REMOVING OBSTRUCTIONS FROM THE SAME.

[Printed in House Ex. Doc. No. 29, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1890.

SIR: I have the honor to submit herewith the accompanying copy of report dated October 30, 1890, from Maj. D. W. Lockwood, Corps of Engineers, giving results of preliminary examination of Russel Fork

of the Big Sandy River, Kentucky, with the view of removing obstructions from the same, made to comply with provisions of the river and harbor act approved September 19, 1890.

Major Lockwood reports that he does not consider this river worthy of improvement, and Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division, is of the same opinion. I concur in the views of these officers.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF MAJOR D. W. LOCKWOOD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, October 30, 1890.

SIR: I have the honor to submit the following report upon the examination of Russel Fork of the Big Sandy River, Kentucky:

Russel Fork is in reality a branch of the Levisa Fork of the Big Sandy River, emptying into the Levisa Fork at a point 99 miles from Louisa.

The stream is to all intents and purposes a mountain torrent, and at the Breaks, about 12 miles above its mouth, the fall is so rapid that the running of loose logs at any stage of water is unprofitable. The 12 miles below the Breaks might be improved somewhat by the removal of bowlders, etc., which would make it possible to raft or float logs at a lower stage than is now practicable, but the benefits to be derived from this, in my opinion, are not at all commensurate with the outlay required. As stated in the report of Mr. Thomas, appended hereto, even push-boat navigation can not be secured, owing to the steep slope.

Were it possible to float logs through the Breaks, thus making the lower part of the stream an outlet for the large timber tracts that border the upper river and its branches, the improvement would be a proper one to make, but to improve about 12 miles of the stream for the purpose of merely facilitating the marketing of the timber along that portion of the stream does not seem to be of sufficient importance to justify me in recommending an appropriation by the United States.

I do not consider the stream to be worthy of improvement.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., October 31, 1890.

Respectfully forwarded to the office of the Chief of Engineers.

Upon the within statement of the present condition of Russel Fork of the Big Sandy River, Kentucky, I reach the same conclusion as the

district engineer, and concur with him in the opinion that the river is not worthy of improvement by the General Government.

O. M. POE,
Colonel, Corps of Engineers,
Division, Engineer Northwest Division.

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

LOUISA, KY., October 25, 1890.

MAJOR: I herewith submit my report upon the examination of the Russel Fork of Big Sandy River, the most important tributary of the Levisa Fork. It takes its rise in the sandy ridge which divides the Big Sandy and Clinch River waters, flowing northwesterly through the "Breaks of the Cumberland," so called, though, in fact, the Pine Mountain, to its junction with the Levisa Fork at a point 99 miles from its mouth at Louisa, and 124.87 miles from the mouth of Big Sandy at Catletsburg. The valley through which the Russel Fork passes is crooked, narrow, and rough, but quite fertile. Its long and sinuous tributaries divide the surrounding country into high, rocky ridges, which have veins of coking coal showing a thickness at the outcrop of from 7 to 9 feet. It drains an area of 600 square miles, but there is no way to determine its average discharge, as there is no record, so far as I know, of its rainfall.

The mouth of Russel Fork is the head of steamboat navigation, and it is only during a freshet that they are enabled to get so far up, generally stopping at Pikeville, 13 miles below, and transferring their freight to pushboats and wagons. Pushboats have run to the mouth of Elkhorn, 12 miles up the Russel Fork, but the river is too rapid for successful navigation even in this small way, and for many years the freighting has been done with wagons. Above Elkhorn the "breaks" destroy the river for any purpose, the running of loose logs even having been a failure, owing to the rough bed and rapid current. The 12 miles of river below Elkhorn could be profitably improved by removing the large bowlders so that timber could be safely transported. It is estimated that \$250 per mile, or \$3,000, would make the desired improvement. It is not deemed advisable to make the improvement for pushboat navigation, as it is not believed that it can be done with safety, owing to the velocity of the current at the stage of water necessary for boats. Still, with the removal of the bowlders from the bends, the chutes would naturally be more regular, and it is possible that pushboat navigation could be carried on with profit and safety. I would, therefore, consider that part of Russel Fork lying below Elkhorn Creek worthy of improvement, and recommend that \$3,000 be appropriated for that purpose.

Respectfully submitted.

B. F. THOMAS,
Assistant Engineer.

Maj. W. D. LOCKWOOD,
Corps of Engineers, U. S. A.

J J 15.

PRELIMINARY EXAMINATION OF GREEN RIVER, KENTUCKY, ABOVE THE MOUTH OF BIG BARREN RIVER, WITH A VIEW OF EXTENDING SLACK-WATER NAVIGATION ON GREEN RIVER.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, March 28, 1891.

GENERAL: Under date of September 20, 1890, I was charged with the preliminary examination of Green River, Kentucky, above the mouth of the Big Barren, provision for this having been made in the river and harbor act of September 19, 1890. The wording of the act is as follows:

Green River, Kentucky, above the mouth of Big Barren River, completing survey with a view of extending slack-water navigation on Green River.

I have the honor to submit the following report with reference to the general subject:

Since the receipt of the letter above alluded to, the Green River has most of the time been at too high a stage to permit of a proper examination being made, and at the present time this high stage continues with no prospect of an immediate change for the better.

In the fall and winter of 1879, a survey of Green River was made under the direction of Maj. William E. Merrill, Corps of Engineers, the work commencing at the mouth of Big Barren and extending upstream 79½ miles. Locations for 8 additional locks and dams above the present upper lock No. 4, were made on Green River, and maps submitted, giving the general character of the stream, besides detail maps of localities selected as lock sites.

The survey was quite complete, the stream being meandered above Honaker's Ferry, near the head of the present pool No. 4, and a line of levels run from pool water at the upper end of the pool to the upper limit of the survey.

It has occurred to me that as a survey has already been made in such detail it may not be necessary to make an additional one, except of special localities covering proposed sites for locks.

At the time Major Merrill's survey was made the slack-water system composed of the four locks and dams on the Green River and the one lock and dam on the Big Barren River, had been leased by the State of Kentucky to the Green and Barren River Navigation Company, and excessive tolls amounting to as much as \$1.20 per registered ton, between the Ohio River and Bowling Green, or \$2.40 for the round trip, were charged.

No boats but those owned and controlled by the Navigation Company could hope to succeed in Green River, and Major Merrill in his report of the survey states as follows:

But inasmuch as the Green River is *de facto* a river that is closed to general commerce, I certainly think that it has no claims upon the general Government for an appropriation.

As the United States now has possession of the locks and dams, the objection to further improvement of Green River, advanced by Major Merrill, will no longer apply.

While the Green River country above the Big Barren is rich in coal and iron, and will furnish large amounts of valuable timber for years to come, the extension of slackwater to the limit of the survey is not deemed advisable at the present time. The pool of dam No. 4 extends up Green River 20 miles above the mouth of the Big Barren. Pool No. 5, the lift of the lock being 13.5 feet, would extend upstream 16.45 miles, and lock and dam No. 6, the lift being the same as for No. 5, would still further extend slack water a distance of 11.03 miles, or to a point a short distance above Mammoth Cave. Two locks and dams would therefore extend slackwater navigation to a point on Green River 47½ miles above the mouth of the Big Barren, and open up the extensive mineral deposits of the Bear Creek and Nolin River districts. Above Mammoth Cave the slope of the river increases and the pools would be much shorter than below, thus increasing the cost of the improvement per mile very materially. In my opinion the river is worthy of improvement to Mammoth Cave, and this would require the construction of two additional locks and dams. The following extracts from the report of Prof. N. S. Shaler, on the Bear Creek and Nolin River mineral districts are made to show the importance of the region that would be opened up by the extension of slackwater navigation as recommended.

The task of the western party of the survey for this year has been to determine the character of the deposits of coal and iron in the easternmost part of the Green River coal field.

So far our efforts have been richly rewarded. In the section where our work has hitherto lain, in the territory between Bear Creek and Nolin River, and for a certain distance to the east and west of those streams, we have determined the position and character of sources of supply for furnaces and coal mines unexcelled by any in the State. At least two veins of workable coal, of good quality for steam purposes and sufficient thickness for profitable working, have been satisfactorily determined.

One of these veins is 4 feet in thickness; seems to carry its thickness well; is admirably disposed for drainage, and could be mined as cheap as any coal in Kentucky. Analysis seems to show that it will answer well for making coke suitable for iron smelting.

The point of most interest, however, is the rich and extensive series of ore beds which have rewarded our search. Not less than five different beds appear at various points in the heights of the hills. Of these one, a bed of 3 to 5 feet or more in thickness, of oölitic ore, contains about 37 per cent. of iron, in a very favorable combination for making metal of good quality. This bed has already been traced over an area of about 20 square miles, and will in itself furnish ore for fifty furnaces for centuries to come. Two other ores promise good results, though, owing to the densely wooded condition of the country, we have not been able to trace them out the whole area as well as the overlying oölitic ore.

The timber in this section is of excellent quality for the uses of the miner and iron-worker. There is an abundance of wood suitable for charcoal and for the supports of mines, etc. Limestone, of excellent quality for furnace use, is found at the base of the hills, and stone suitable for the masonry of furnaces can be had at every point.

I am thoroughly satisfied that this region is full of promise and that it only wants capital and energy to give it development. With the revival of the iron industry from the late panic, a restoration which seems just at hand, I am confident that this region will come to the knowledge of the world.

THE NOLIN RIVER DISTRICT.

In Edmondson and Grayson counties, north of Green River, between Nolin River and Bear Creek, is an area of considerable size, called the Nolin River District. The ores of this district are stratified carbonates and limonites, found near the base of the coal measures. The ore of most value occurs above the conglomerate. It is about 4 feet thick, and, so far as present developments indicate, underlies an area of large extent. It is almost wholly undeveloped. A number of years since a small charcoal furnace was established on the Nolin River, but it was so far from market, and transportation of the iron was so expensive, that the enterprise soon failed. It ran long enough, however, to establish the fact that an excellent iron could be made from these ores.

In addition to the great amount of timber available for charcoal stone coal occurs in the same region. This coal is lowest of the series and is of most excellent quality, analysis showing it to be far superior to the higher coals of western Kentucky, which are the ones most generally mined. The region is now more accessible than formerly, as it lies within 15 miles of the Louisville, Paducah and Southwestern Railroad, but the lack of transportation facilities directly to it has prevented its development.

The aggregate amount of ore, coal, and timber suitable for charcoal in this region is immense and offers great opportunities for development. It is one of the most richly endowed undeveloped iron regions of the State.

A tracing* is forwarded in a separate package of the Green River from the mouth of Big Barren to a short distance above Mammoth Cave and of the Big Barren to Lock No. 1. Profiles showing the pools, etc., with the proposed lift of locks as planned are also given. For a statement of the commerce of the Green and Barren rivers I would respectfully refer to my annual report for 1890.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer,
Northwest Division.)

* Not printed.

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., March 30, 1891.

Respectfully forwarded to the office of the Chief of Engineers.
I concur in the conclusions reached by Major Lockwood in this report.

O. M. POE,
*Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.*

SUPPLEMENTARY REPORT.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, August 11, 1891.

GENERAL: Under date of March 28, 1891, I had the honor to submit a report on the examination of Green River above the mouth of the Big Barren, in which I stated that—

In my opinion the river is worthy of improvement to Mammoth Cave, and this would require the construction of two additional locks and dams.

Department letter of April 2, 1891, acknowledging the receipt of the above report, contained the following:

As the stream is considered worthy of improvement by yourself and the division engineer, and no further survey is deemed necessary, it is requested that you submit, at as early a day as practicable, a final report, with project for improvement and estimate of cost.

The following is submitted in compliance with the above:

The original survey for the location of Lock No. 5, the first one above the mouth of the Big Barren, made by Mr. Alonzo Livermore, State Engineer of Kentucky, in charge of the slack-water improvement of the Green and Barren rivers, located the site at Floyd Landing, 20½ miles above Lock No. 4, and this same site was selected by Mr. R. H. Fitzhugh, in 1879. The latter selected as an alternate location a point just below the mouth of Bear Creek.

In like manner Mr. Fitzhugh selected a site for Lock No. 6, about 2½ to 3 miles above the mouth of Nolin River, and an alternate location was made just below the mouth of that stream. As the mineral deposits in the Bear Creek and Nolin River districts are among the most important in this part of Kentucky it would seem to be advisable to furnish as much water to these streams as possible from the dams on the main river, especially as by so doing the slackwatering of the main river would be in no wise impaired or interfered with. The combined lift of the two locks to carry slack water to Mammoth Cave is 27 feet; this by Mr. Fitzhugh's first scheme was to be divided equally between the two locks, giving them each a lift of 13.5 feet. This is not essential, as, if necessary, the lock could be given a lift of 16 or 17 feet and the site changed to just below the mouth of Nolin River, while the site of No. 5 could be changed to below the mouth of Bear Creek, and in this way both of the small streams be largely benefited. Mr. Fitzhugh seems to have been influenced in selecting the sites he did by the physical conditions of the localities, but from his report I conclude that he had no means of boring more than 10 feet below the bottom for rock, and where he did not find rock he reports a compact gravel which would answer very well for a foundation for both lock and dam. Before

adopting the exact sites more careful special examinations should be made, with borings, to determine the actual conditions. The cost of the two locks will be about the same, whether of equal or unequal lift where the difference is so small, and the estimate is therefore made on the basis of one lock of 13.5 feet lift.

The commerce of the upper river will not require larger locks than on the lower river, and besides the width of the stream is such that there is not room enough for wider locks and still leave sufficient spill for the dams. The locks projected are, therefore, of the same size, as regards length and width, as the locks already built on Green River, to wit, 161 feet long between hollow quoins and 36 feet width of chamber, with 4 feet on the lower miter sill.

The following is the estimate of cost of lock and dam, etc., complete:

Masonry in place, cement, and labor included:

Dressed face stone, 1,362 cubic yards, at \$16.55	\$22,541.10
Quarry face stone, 1,718 cubic yards, at \$13.75	23,622.50
Backing stone, 4,291 cubic yards, at \$8.70	37,331.70
Coping stone, 250 cubic yards, at \$20.75	5,187.50
Special stone, 96 cubic yards, at \$18.65	1,790.40

Cost of masonry	90,473.20
Two upper and 2 lower gates	4,000.00
Cofferdam and excavation	6,000.00
Dam complete	40,000.00
Abutment	5,000.00
Guide walls	10,000.00
Two lock-houses, at \$1,600 each	3,200.00
Engineering and contingencies	12,000.00

Total 170,673.20

Lock No. 6, if located below the mouth of Nolin River, would, according to Mr. Fitzhugh's report, be on rock. It is thought that the foundations for the two locks will not cost more than an average of \$10,000 each, even if No. 5 is established on gravel, so that the estimated cost of each lock complete would be \$180,673.20, and the cost therefore of constructing the two locks to carry slackwater navigation to Mammoth Cave would be \$361,346.40.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., August 12, 1891.

Respectfully forwarded to the office of the Chief of Engineers, approved.

O. M. POE,
*Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.*

APPENDIX K K.

IMPROVEMENT OF HARBORS ON LAKE SUPERIOR.

REPORT OF CAPTAIN W. L. FISK, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|---|---|
| 1. Harbor at Grand Marais, Minnesota. | 6. Harbor at Ashland, Wisconsin. |
| 2. Harbor at Agate Bay, Minnesota. | 7. Harbor at Ontonagon, Michigan. |
| 3. Harbor at Duluth, Minnesota. | 8. Eagle Harbor, Michigan. |
| 4. Harbor at Superior Bay and St. Louis Bay, Wisconsin. | 9. Harbor at Marquette, Michigan. |
| 5. Minnesota Point at Superior, Wisconsin. | 10. Harbor of refuge at Grand Marais, Michigan. |

EXAMINATION.

11. Allouez [Allouez] Bay at the west end of Lake Superior, also the Nemadji River for a distance of 4 miles above its mouth, with a view of determining the best method of improving and making them available as a portion of the harbor system of the city of Superior, Wisconsin.

HARBOR LINES.

- | | |
|---|--|
| 12. Establishment of harbor lines at Duluth, Minnesota, Bay of St. Louis, Superior Bay, and the adjacent waters, Minnesota and Wisconsin. | 13. Establishment of harbor lines in Portage Lake, Michigan. |
| | 14. Resurvey and relocation of harbor line in Portage Lake, Houghton County, Michigan. |

UNITED STATES ENGINEER OFFICE,
Duluth, Minn., July 8, 1891.

GENERAL: I have the honor to transmit herewith annual reports upon works of river and harbor improvement at present in my charge for the fiscal year ending June 30, 1891.

Very respectfully, your obedient servant,

W. L. FISK,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

K K 1.

IMPROVEMENT OF HARBOR AT GRAND MARAIS, MINNESOTA.

On the north shore of Lake Superior there are very few localities where safe anchorage for vessels can be found; and Grand Marais offers the only harbor of refuge during storms between Agate Bay and Pigeon River, the international boundary, a distance of 120 miles. It is not yet a shipping port of much importance, but it is so near the rich iron ore deposits of the Vermillion Range that it is probable a railroad will soon be built to connect it with them.

At present the anchorage area of 16 feet depth is a little over 15 acres in extent, and the dredging to be done under the contract now in force will increase it to about 22 acres. It is compact in shape and fairly well protected, but this space is not of sufficient size to permit more than one or two vessels to maneuver with safety. The harbor is so small its entire area, 61 acres, should be utilized. To do this in the best manner would require 500 feet extension of the breakwater and additional dredging to the amount of about 450,000 cubic yards. The extension of the breakwater would cost about \$100 per foot, or \$50,000; the additional dredging, at the present contract price of 20 cents per yard, would cost about \$90,000 more, which with 10 per cent. for contingencies would make a total of \$154,000 to complete this excellent harbor. The original estimate of the cost of improving this harbor was \$139,669.40 but contemplated protecting and dredging only a part of it.

Small repairs have been made to the breakwater, which is in good condition, except that a small amount of stone has been displaced from the outer pockets of the cribs, and this will be replaced at once.

Work under the existing contract (see abstract of bids following) began on the 6th of June, and to end of the month 29,929.1 cubic yards had been dredged.

This work is in the collection district of Duluth, Minn. Duluth, Minn., is the nearest port of entry. The nearest light-house is situated on the breakwater at Grand Marais.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT GRAND MARAIS, MINNESOTA.

By act of Congress—

Approved March 1, 1879.....	\$10,000
Approved June 14, 1880.....	10,000
Approved March 3, 1881.....	20,000
Passed August 2, 1882.....	20,000
Approved July 5, 1884.....	10,000
Approved August 5, 1886.....	10,000
Passed August 11, 1888.....	15,000
Approved September 19, 1890.....	22,350

Total 117,350

EXPENDITURES.

Amount expended under approved project to June 30, 1891.....	\$94,461.15
Balance available July 1, 1891.....	2,732.85

ESTIMATES.

Original (estimated) amount required to complete the improvement....	\$139,669.40
Amount that can be profitably expended	100,000.00

Money statement.

July 1, 1890, balance unexpended	\$1,324.51
Amount appropriated by act approved September 19, 1890	22,350.00
	<hr/>
June 30, 1891, amount expended during fiscal year	23,674.51
	785.66
	<hr/>
July 1, 1891, balance unexpended	22,888.85
July 1, 1891, outstanding liabilities	\$5,985.82
July 1, 1891, amount covered by uncompleted contracts	14,170.13
	<hr/>
	20,156.00
	<hr/>
July 1, 1891, balance available	2,732.85
	<hr/>
{ Amount (estimated) required for completion of existing project	22,319.40
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	100,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals received for dredging at Grand Marais, Minn., opened at Duluth, Minn., December 6, 1890.

No.	Name and address of bidder.	Price per cubic yard.
		<i>Cents.</i>
1	Williams, Daugherty & Upham, Duluth, Minn	20
2	Charles Barker, Duluth, Minn	23

Contract was awarded to Williams, Daugherty & Upham with the approval of the Chief of Engineers.

Contract dated December 15, 1890; work to be completed by September 15, 1891.

COMMERCIAL STATISTICS, GRAND MARAIS, MINNESOTA.

Arrivals and clearances of vessels for 1890.

Designation.	Arrivals.	Clearances.	Total.
Coastwise	268	268	536
Foreign	0	0	0

Have been unable to obtain the tonnage of these vessels. So far as known there have been no new lines of transportation established.

Freight received and shipped, 1890.

Receipts:	Tons.
General merchandise	120
Lumber	150
Total.	270
Shipments:	
General merchandise	5

Freight received and shipped for 10 years.

Year.	Tons.	Value.	Year.	Tons.	Value.
1881	264	\$30,293	1886	475	\$48,519
1882	224	25,691	1887	312	28,069
1883	239	27,565	1888	480	44,871
1884	270	30,198	1889	252	23,349
1885	390	41,484	1890	275	32,085

Arrivals and clearances of vessels for 10 years..

Year.	Arrivals.	Clearances.	Year.	Arrivals.	Clearances.
1881	108	108	1886	210	210
1882	134	134	1887	164	164
1883	131	131	1888	190	190
1884	152	158	1889	168	168
1885	188	190	1890	268	268

K K 2.**IMPROVEMENT OF HARBOR AT AGATE BAY, MINNESOTA.**

Agate Bay is a small indentation of the north shore of Lake Superior, and though it has ample depth of water it is not protected from the southwest or from the reverse swells of the more dangerous storms of the northeast, but the little security it afforded was sufficient to warrant the construction of extensive ore docks and docks for the handling of merchandise. The commerce soon grew out of all proportion to the size of the harbor, and for the security of this commerce it was necessary to supplement the natural protection by artificial means. Two piers projecting from either shore were therefore proposed, and work upon the eastern pier was commenced in 1887. This pier is now 550 feet in length and the contract now in progress will add 200 feet to it, leaving only 250 feet more to be built to complete it.

There is not yet perfect security from southwest storms for vessels lying at the merchandise dock, but it is not longer necessary to leave the harbor and seek security elsewhere. The favorable results already obtained with the portion of the breakwater now built are much greater than anticipated, and emphasize the advisability of speedily completing the remainder of the projected piers.

The Duluth and Iron Range Railroad contemplate putting in other large ore docks to the westward of those now built, in which case, in my opinion, the next work should be done on the west pier, and in order to give good shelter the entire 900 feet of it should be completed; this would cost about \$135,000, and this amount could be profitably expended during the year.

The Iron Range is the only railroad using this harbor as a shipping point, and the business of the place is mainly subsidiary to the iron ore interests of the Vermillion Range. Of iron ore alone there were shipped from this port during the season of 1890, 984,215 gross tons.

Agate Bay (known locally as Two Harbors) is in the collection district of Duluth, Minn., which is also the nearest port of entry. The nearest light-house is situated on the south pier Duluth Canal, Minnesota.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT AGATE BAY, MINNESOTA.

By act of Congress:	
Approved August 5, 1886	\$22,500.00
Passed August 11, 1888	15,000.00
Approved September 19, 1890	25,000.00
Total	62,500.00

EXPENDITURES.

Amount expended under approved project to June 30, 1891	36,255.79
Balance available July 1, 1891	2,844.21

ESTIMATES.

Estimated amount required to complete the improvement	181,708.00
Estimated amount required annually for preserving and maintaining when improvement is completed	2,000.00

Money statement.

July 1, 1890, balance unexpended	\$1,980.21
Amount appropriated by act approved September 19, 1890	25,000.00
	<hr/> 26,980.21
June 30, 1891, amount expended during fiscal year	736.00
July 1, 1891, balance unexpended	26,244.21
July 1, 1891, amount covered by uncompleted contracts	23,400.00
	<hr/> 2,844.21
{ Amount (estimated) required for completion of existing project	181,708.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	135,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals received for constructing 200 linear feet of breakwater at Agate Bay, Minnesota, opened at Duluth, Minn., January 15, 1891.

No.	Name and address of bidder.	Price bid per running foot.		Total.
		For cribs, including super-structure.	For embankment.	
1	Morrison & McGregor, Duluth, Minn	\$48.00	\$100.00	\$29,600
2	Porter, Sang & Co., Duluth, Minn	61.40	60.00	24,280
3	Campbell & McDonald, Duluth, Minn	50.00	67.00	23,400
4	A. K. Truax & Co., Duluth, Minn	64.90	64.94	25,968

Contract was awarded to Campbell & McDonald with the approval of the Chief of Engineers.

Contract dated February 7, 1891; work to be finished by November 1, 1891.

COMMERCIAL STATISTICS, TWO HARBORS, MINNESOTA.

Vessels arriving and departing.

Year.	Vessels.	Estimated tonnage.
1885.....	*174	285, 800
1886.....	*263	480, 000
1887.....	465	897, 500
1888.....	749	1, 436, 000
1889.....	1, 255	2, 400, 000
1890—		
Steam.....	968	} 1, 050 2, 625, 000
Sail.....	82	

*In addition to these were numerous north shore and other boats, and daily boats between Duluth and Two Harbors, not included in this statement.

The decrease in number of vessels and increase in tonnage for 1890 is explained by the increased capacity of new steamers, rendering a less number necessary to transact the business.

The Minnesota Steamship Company put four new steel steamers into the ore trade last year, their increased capacity tending to reduce the number of vessels engaged while the tonnage increased.

Vessel tonnage for two years.

1890.....	2, 625, 000
1889.....	2, 400, 000
Increase.....	225, 000

Receipts and shipments.

	1885.	1886.	1887.	1888.	1889.	1890.
	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
Ore shipped.....	225, 484	304, 396	394, 252	509, 964	924, 064	984, 215
Other freight received and shipped.....	10, 895	21, 954	6, 620	30, 352	31, 731	37, 268
Total.....	236, 379	326, 350	400, 872	540, 316	955, 795	1, 021, 483

Estimated value of freight received and shipped (exclusive of ore).

1887.....	\$96, 000
1888.....	212, 000
1889.....	222, 000
1890.....	246, 000

K K 3.

IMPROVEMENT OF HARBOR AT DULUTH, MINNESOTA.

THE CANAL OR ENTRY.

Nothing has been done to the canal in the way of improvement or repairs during the year, the ownership still remaining in doubt. The question is unsettled and is somewhat complicated owing in part to the fact that the deed of the city of Duluth to the lots covered by the canal was accepted in part only by the act of Congress of August 11,

1888, and to the claims of Mr. Wilhelm Boeing to property not included in this deed, but which is also covered by the canal.

Subsequent efforts to have the difficulty adjusted have not resulted successfully and the subject is still in abeyance.

The head of the south pier is very badly damaged and needs to be replaced with a new structure or otherwise the light-house is in danger of being carried away.

The north pierhead has also been damaged but not so badly as the other.

There is now in hand about \$15,000 for repairing the piers that has been reserved from different appropriations for the harbor. This amount will just about suffice for the pierheads, but if expended would leave nothing in hand, while it would seem prudent that at least \$10,000 should be constantly available for emergencies.

THE HARBOR BASIN.

No work has been done upon the harbor basin during the year, and no complaints of shoaling have been heard. This basin should be considerably enlarged, especially where it joins the new channel east of Rice Point, as boats are constantly backing out from one wharf to move to another, and with probably less than a dozen exceptions all vessels bound to West Superior this season have come in through the canal, and passed through this basin and the new channel over to the West Superior wharves. At least \$75,000 could be profitably expended in this work during the next year.

RICE POINT CHANNEL.

The dredging for the new channel east of Rice Point was commenced in 1889, but as the funds allotted were not sufficient to give a navigable channel through, it was not carried beyond the old dike. When the last river and harbor act was passed the opening of this channel was considered of such importance that authority was given by the Secretary of War to continue the dredging upon the terms of the 1889 contract without losing the time necessary to advertise for new bids, and an agreement to that effect was entered into with Williams, Upman & Co., the former contractors. The act of Congress was signed on the 19th of September, and dredging was begun on the 24th. When work stopped for the season sufficient had been done to permit the passage of large boats with careful handling by tugs.

An examination of the channel made just before the breaking up of the ice in April last, showed that it had held unexpectedly well, but had a least width between 15-foot curves of only 45 feet. Work was resumed on the 28th of April, as soon as the ice would permit, the channel carefully trimmed up and widened until when the funds were exhausted May 28, it had a least width of about 110 feet between 15-foot curves. The length of this channel is 1.6 miles, and during the year 234,366.4 cubic yards were dredged from it. The present project calls for a width in this channel of 200 feet, but in my opinion it should be at least 400 feet to safely and conveniently accommodate the traffic now passing through it. The custom-house records show 634 arrivals and 622 departures of vessels from West Superior during the season of 1890, a total of 1,256 trips, with an aggregate registered tonnage of 1,541,777 tons, of which at least 95 per cent. would have used this channel had it been open, judging from the proportion of West Superior

arrivals passing through it so far this season; in addition it is used by numerous tugs, light or with large rafts of logs in tow, and the large ferry-boats make hourly trips in both directions. It is by far the most important part of the harbor improvement at the head of the lakes, and \$100,000 could be profitably expended upon it during the next fiscal year.

The estimated cost of the 200-foot channel was \$119,552, of which \$63,000 has already been allotted, leaving \$56,552 to complete.

NORTH SHORE CHANNEL, ST. LOUIS BAY.

With the \$40,000 allotted for this channel from the appropriation made August 11, 1888, a channel of such width as could be made at a single cut of a dredge was dug between the deep waters at Rice Point and Grassy Point. Though it has a depth of 14 feet throughout its length, its width is not sufficient to render it safely practicable for vessels of ordinary size. Important manufacturing industries are now located at Grassy Point, and the obliteration of this insignificant channel by neglect would work a great injury to these important interests and to the commerce dependent upon them. Aside from this it is a matter of considerable economy to complete such channels as soon as possible, and thus avoid all expensive redredging. The river and harbor act of September 19, 1890, gave \$60,000 for the continuation of this work; dredging was begun under the new contract May 28, 1891, and to June 30, 90,530.9 cubic yards had been taken out. The money in hand is expected to give this channel an available width of about 100 feet.

The estimated cost of this channel is \$163,000. There therefore remains to be supplied \$63,000, which amount could be most advantageously expended during the next year.

PARK POINT CHANNEL.

Nothing has been done to this proposed channel.

HARBOR LINES.

New harbor lines were established by the War Department, as recommended by a Board of Engineers, and are shown on accompanying chart.

IMPROVEMENTS WHICH ARE BEING CONSIDERED.

As soon as the possession of the Duluth Canal or entry is vested in the United States the improvement of this important property will have to be undertaken. The estimated cost of the improvements proposed and described in House Ex. Doc. No. 217, Fifty-first Congress, first session, is \$2,345,842.77.

The dredged areas of the harbor will require deepening to 20 or 22 feet as soon as this depth is secured in the navigable channels below. No estimate has been prepared for this yet, as the time when it will be required is indefinite.

The width of the projected channel east of Rice Point is 200 feet. As very few of the recent lake steamers are under 300 feet in length, this width of channel is not sufficient to allow such vessels to back out safely from docks built along it, and it is possible that it will shortly be necessary to increase its width to 400 feet. This increased dredging would cost \$100,000.

The St. Louis River above Grassy Point has a depth of over 10 feet for several miles, and 8 feet to Fond du Lac Station. Four or 5 feet can be carried up to the foot of the rapids, from which point up the river has a fall of about 600 feet in less than 7 miles. The utilization of this immense water power has already been commenced, the first dam, located at Thomson, being now about completed and giving a head of 40 feet, but it appears that the existence of a deep navigable channel to Fond du Lac is considered as essential to the success of any enterprises in this locality. No estimates, based upon the needs of a prospective commerce which might be created by the erection of manufactories at the foot of the rapids of the river, have been prepared, as the recent survey of this river with a view to its improvement has not been completed.

CONDITION OF WORK.

The canal piers are in fairly good condition, but need extensive repairs, particularly the superstructure. The entire work will eventually require to be replaced with more durable material.

The ruling depths in the portions of the harbor dredged by the United States are:

	Feet.
In canal	17
In the inner basin or harbor	16
In channel on north shore of St. Louis Bay	16
In new channel east of Rice Point	16

RÉSUMÉ OF RECOMMENDATIONS.

For next year:

For canal piers	\$25, 00
For the Rice Point Channel	100, 000
For North Shore Channel, St. Louis Bay	63, 000
For enlargement of harbor basin	75, 000
Total	263, 000

This work is in the collection district of Duluth, Minn., which is also the port of entry. The nearest light-house is situated on the outer end of the south pier of the Duluth Canal, and a range light is located on the inner end of the same pier.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT DULUTH, MINNESOTA.

By act of Congress approved—

March 3, 1871	\$60, 000. 00
June 10, 1872	50, 000. 00

Allotted from act passed March 3, 1873

36, 049. 20

By act of Congress approved—

June 23, 1874	10, 000. 00
March 3, 1875	35, 000. 00
August 14, 1876	15, 000. 00
June 18, 1878	30, 000. 00
March 3, 1879	25, 000. 00
June 14, 1880	25, 000. 00
March 3, 1881	40, 000. 00

By act of Congress passed August 2, 1882

45, 000. 00

By act of Congress approved—

July 5, 1884	45, 000. 00
August 5, 1886	56, 250. 00

By act of Congress passed August 11, 1888

80, 000. 00

By act of Congress approved September 19, 1890

100, 000. 00

Total

652, 299. 20

The following statement shows the manner in which the appropriations have been expended. The amount expended under the different classes of work includes the cost of soundings, superintendence, buoying, and contingencies:

Total amount expended to June 30, 1891:

Breakwater.....	\$110,000.00
Canal piers, etc.....	77,215.26
Dredging.....	403,517.72
Total.....	590,732.98

Expended prior to present project:

Breakwater.....	110,000.00
Canal piers, etc.....	45,698.33
Dredging.....	114,953.48
Total.....	270,651.81

Expended under present project (adopted in 1881):

Canal piers, etc.....	31,516.93
Dredging.....	288,564.24
Total.....	320,081.17

Amount required annually for preserving and maintaining..... 10,000.00

Money statement.

July 1, 1890, balance unexpended.....	\$14,015.92
Amount appropriated by act approved September 19, 1890.....	100,000.00
	<hr/>
June 30, 1891, amount expended during fiscal year.....	114,015.92
	51,182.19
July 1, 1891, balance unexpended.....	62,833.73
July 1, 1891, outstanding liabilities.....	\$1,267.51
July 1, 1891, amount covered by uncompleted contracts.....	41,324.83
	<hr/>
	42,592.34
July 1, 1891, balance available.....	20,241.39
	<hr/>
{ Amount (estimated) required for completion of existing project.....	224,526.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893.....	263,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals received for dredging in the harbor of Duluth, Minn., opened at Duluth, Minn., December 6, 1890.

No.	Name and address of bidders.	Price per bid for dredging per cubic yard.
1	Williams, Daugherty & Upham, Duluth, Minn.....	Cents. 14
2	Charles S. Barker, Duluth, Minn.....	15½

Contract awarded to Williams, Daugherty & Upham, with the approval of the Chief of Engineers.

Contract dated December 15, 1890; work to be completed by October 1, 1891.

COMMERCIAL STATISTICS, DULUTH, MINNESOTA.

Arrivals and clearances of vessels for 1889 and 1890.

Designation.	1889.				1890.			
	Arrivals.	Clearances.	Total.	Tonnage.	Arrivals.	Clearances.	Total.	Tonnage.
Coastwise.....	1,065	1,085	2,150	2,299,278	1,102	1,125	2,227	2,554,020
Foreign.....	198	180	378	182,845	164	143	307	186,334
Total.....	1,263	1,265	2,528	2,482,123	1,266	1,268	2,534	2,740,354

Comparative statement of arrivals and clearances, 1889 and 1890.

Year.	Vessels.	Tonnage.	Average tonnage.
1890.....	2,534	2,740,354	1,081
1889.....	2,528	2,482,123	970
Increase.....	6	288,231	111

There were no new lines of transportation established last year.

Principal domestic commodities received by lake, 1890.

	Tons.
Coal.....	735,995
Lime and other building stone.....	28,424
Cement and lime.....	18,131
Salt.....	7,656
Railroad iron and other materials.....	24,832
General merchandise.....	185,885
Total.....	1,000,923

Shipments by lake, 1890.

	Tons.
Wheat.....	180,869
Flour.....	149,112
Bran.....	9,937
Oats.....	3,939
Corn.....	2,942
Barley.....	2,061
Flax.....	1,082
Rye.....	232
Lumber.....	2
General merchandise.....	22,188
Total.....	352,364

Receipts of coal and flour for eight years.

Year.	Coal.	Flour for shipment eastward.	Year.	Coal.	Flour for shipment eastward.
	Tons.	Tons.		Tons.	Tons.
1883.....	420,000	91,896	1887.....	1,041,000	129,627
1884.....	372,000	79,801	1888.....	1,435,000	171,223
1885.....	605,000	113,190	1889.....	1,645,000	198,053
1886.....	736,000	133,036	1890.....	*735,995	149,112

* The falling off of coal shipments is due to the fact that the figures given for the year 1890 contain the tonnage for Duluth only, whereas the figures given for the former years include the receipts of coal for the head of the lake (Duluth and Superior). This is the result of a new and superior method of bookkeeping in the Duluth revenue office.

2494 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

The storage capacity of the Duluth elevator system is 21,300,000 bushels, and that of the Duluth elevators proper 12,650,000 bushels. The following table gives the receipts and shipments of wheat for 20 years:

Year.	Receipts.	Shipments.	Total.	Year.	Receipts.	Shipments.	Total.
Ending Dec. 31—	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	Ending Aug. 31—	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
1890*.....	177,800	180,860	358,768	1890.....	40,430	43,610	84,040
1889.....	513,827	409,410	923,237	1879.....	45,722	44,617	90,339
1888.....	239,802	404,485	644,287	1878.....	54,092	54,000	108,092
1887.....	514,089	585,558	1,099,647	1877.....	13,817	15,117	28,934
1886.....	675,977	530,048	1,206,025	1876.....	43,536	41,292	84,828
1885.....	446,500	421,973	868,563	1875.....	34,137	32,436	66,573
1884.....	411,688	346,537	758,225	1874.....	67,234	72,725	139,959
Ending Aug. 31—				1873.....	59,444	47,495	106,939
1883.....	141,234	137,607	278,841	1872.....	27,948	28,531	56,479
1882.....	97,987	99,264	197,251	1871.....	16,708	16,345	33,043
1881.....	99,965	85,966	185,931				

* The figures prior to 1890 were given for the head of the lake (Duluth and Superior), those for 1890 give the quantities for Duluth only.

Average vessel tonnage for 6 years.

	Tons.
1885.....	761
1886.....	778
1887.....	812
1888.....	837
1889.....	970
1890.....	1,061

Comparative statement of arrivals and clearances of vessels at Duluth for 14 years.

Year.	Arrivals.	Clearances.	Total.	Year.	Arrivals.	Clearances.	Total.
1877.....	329	228	567	1884.....	888	903	1,791
1878.....	406	343	749	1885.....	808	899	1,707
1879.....	502	497	999	1886.....	1,026	965	2,021
1880.....	524	524	1,048	1887.....	1,227	1,238	2,475
1881.....	666	660	1,326	1888.....	1,100	1,100	2,200
1882.....	833	832	1,665	1889.....	1,263	1,265	2,528
1883.....	796	779	1,575	1890.....	1,266	1,268	2,534

Value of exports and imports, and duties on imports.

Year.	Exports.	Imports.	Duties on imports.
1890.....	\$1,521,751	\$48,832.13	5,255.86
1889.....	1,436,447	21,852.00	2,931.00

Foreign bonded merchandise in transit through the United States.

Year.	Value.	Duties.	Year.	Value.	Duties.
1885.....	\$96,385	\$46,971	1888.....	\$245,094	\$173,048
1886.....	94,540	52,576	1889.....	793,127	394,572
1887.....	82,415	52,205	1890.....	1,202,014	(*)

* The bonding of transit goods having been dispensed with, this column may hereafter be omitted.

Opening and closing of navigation.

Year.	Opening.	Closing.	Year.	Opening.	Closing.
1885	Apr. 27 ...	Nov. 29.	1889	Apr. 11 ...	Dec. 4.
1886	May 7 ...	Dec. 14.	1890	Apr. 16 ...	Dec. 8.
1887	May 4 ...	Dec. 28.	1891	Apr. 30 ...	.....
1888	May 11 ...	Dec. 31.			

NOTE.—Dates prior to 1885 are given in Annual Report of the Chief of Engineers for 1885.

K K 4.

IMPROVEMENT OF HARBOR AT SUPERIOR BAY AND ST. LOUIS BAY, WISCONSIN.

The natural channel connecting Superior Bay with Lake Superior is at the southern extremity of Superior Bay. It was originally obstructed by shifting bars with scarcely 9 feet of water over them, to remedy which the citizens of Superior, previous to 1866, had made some attempts at pier work, which was subsequently taken in hand by the United States and the improvements continued until the piers have reached an aggregate length of 5,650 feet.

When the improvement was commenced 12 feet depth in the channel was more than sufficient to meet the requirements of the largest vessels. This depth has been increased and maintained for some time at 17 feet and at no distant day will have to be still further increased to 22 feet. The crib piers which define this channel are in most part badly conditioned for the present depth of 17 feet, they having been intended originally for not over 12 feet. A further increase in the depth of the channel may possibly make it necessary to replace such with better proportioned structures.

In the mean time the superstructures will have to be extensively repaired. In fact, extensive repairs are urgently needed now, but the \$15,000 held in reserve for this purpose is not safely sufficient to meet the damages liable to result from a single severe storm. It is in reality an emergency fund, and until something more is in sight can not be properly used in making general repairs. It is in the interest of economy as matters stand at present to postpone all general repairs to the latest moment pending the consideration of the subject of reconstruction, but it is hoped that the greater portion of the present substructure cribs can be retained. In any event it will be necessary to maintain a reserve fund for repairs of all kinds until the general repairs are completed. At present this should not be less than \$15,000.

The shore on the Wisconsin side is advancing rapidly, and soon the sand which drifts around the end of the Wisconsin pier will necessitate the extension of this pier. If this extension is to provide for 20 feet depth it will cost \$30,500.

CHANNEL IN SUPERIOR BAY.

The channel in Superior Bay has neither the directness nor width to permit vessels to reach Connor Point safely without the assistance of a tug or local pilot, though its condition has been vastly improved in the past few years. Its present condition is shown on the accompanying map.

In order that vessels may navigate this channel at all times safely it is essential that it be widened and straightened considerably.

During the next year \$50,000 could be advantageously expended in continuation of this work.

QUEBEC DOCK CHANNEL.

No work was done on this channel during the year.

THE NEMADJI RIVER.

The commerce on the Nemadji River is increasing, owing to the location upon its banks of sawmills and brick kilns, which depend upon the water transportation it affords to get their products to market.

The bar at its mouth is a serious obstruction and was dredged during May last, but will probably require redredging each year after the spring floods to maintain a servicable channel; this will require about \$5,000 annually.

CHANNEL ALONG WISCONSIN DOCK LINE, ST. LOUIS BAY.

The projected channel between Connor Point and Grassy Point along the West Superior dock line will be about 12,000 feet in length; 6,000 feet is now navigable and the contract in progress will add to this about 3,000 feet which will have a width of 50 or 60 feet.

The portion of this channel in the vicinity of the Northern Pacific Railroad bridge where the principal wharves are located is now being widened with the intention of having the north opening of this draw also dredged out.

During the year 58,922.7 cubic yards have been dredged in extending and 51,453 cubic yards in widening the channel.

The width is hardly sufficient to permit vessels to enter or leave the dock slip safely. There is great danger of their colliding with the farther bank and injuring their steering or propelling apparatus in doing this. Furthermore, this movement is a slow one and practically blocks the channel until the maneuver is completed. The channel should be widened to 400 feet in the vicinity of the docks. The sum of \$50,000 could be judiciously expended in the improvement of this channel during the ensuing year.

POSSIBLE DEEPENING OF CHANNELS.

All the channels in Superior and St. Louis bays will ultimately require deepening to 20 feet as soon as this depth is secured in the channels below. No estimate of the cost of this additional work has been prepared yet, as the time when it will be necessary to do the work is indefinite.

CONDITION OF WORK.

The entry piers are in fair condition but need extensive repairs, particularly the superstructure, to render them secure. The beach protection is still intact although insufficient. The ruling depths in the channels dredged by the United States are:

	Feet.
From Connors Point to the entry	16
From Northern Pacific Railroad Dock to the entry	16
In front of Quebec Dock	16
Throughout the entry between piers	16
Channel in St. Louis Bay	16

RECOMMENDATIONS FOR NEXT YEAR.

For reserve fund for entry piers	\$15,000
For extension of the south pier of entry	30,500
For the channel in Superior Bay	50,000
For dredging at the mouth of the Nemadji River	5,000
For channel in St. Louis Bay	75,000

Total 175,500

Superior, West Superior, and Connors Point are in the collection district of Superior, Wis., Marquette, Mich., being the port of entry. The nearest light-house is situated on the outer end of north pier of the Superior entry.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT SUPERIOR BAY AND ST. LOUIS BAY, WISCONSIN.

By act of Congress approved—

March 3, 1867	\$63,000.00
April 10, 1869	45,000.00
July 7, 1870	40,000.00
March 3, 1871	60,000.00
June 10, 1872	50,000.00

Allotted from act approved March 3, 1873 63,950.80

Allotted from appropriation for "repairs of harbors on northern lakes" 5,433.00

By act of Congress approved—

August 14, 1876	3,000.00
June 18, 1878	3,000.00
March 3, 1879	5,000.00
June 14, 1880	5,000.00
March 3, 1881	10,000.00
August 2, 1882	40,000.00
July 5, 1884	45,000.00
August 5, 1886	22,500.00

By act of Congress passed August 11, 1888 50,000.00

By act of Congress approved September 19, 1890 65,000.00

Total 575,883.80

EXPENDITURES.

Amount expended under original project adopted in 1867 258,000.00

Amount expended under project recommended by Board of Engineers in 1873 77,513.26

Amount expended under present project to June 30, 1891 182,455.43

Total 517,968.69

The following statement shows the manner in which the appropriations have been expended. The amount expended under the different classes of work includes the cost of examinations, soundings, superintendence, buoying, and contingencies:

Repairs and beach protection	\$13,233.00
Construction and repairs to piers	318,443.53
Dredging	186,292.16

Total 517,968.69

Money statement.

July 1, 1890, balance unexpended \$16,050.54

Amount appropriated by act approved September 19, 1890 65,000.00

81,050.54

June 30, 1891, amount expended during fiscal year 9,375.89

July 1, 1891, balance unexpended 71,674.65

July 1, 1891, outstanding liabilities \$13,759.54

July 1, 1891, amount covered by uncompleted contracts 32,256.54

46,016.08

July 1, 1891, balance available 25,658.57

2498 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

{ Amount (estimated) required for completion of existing project \$226, 736. 00
 { Amount that can be profitably expended in fiscal year ending June 30, 1893 175, 500. 00
 { Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals received for dredging in Superior Bay and St. Louis Bay, Wisconsin, opened at Duluth, Minn., February 10, 1891.

No.	Name and address of bidder.	Prices bid for dredging per cubic yard.
		<i>Cents.</i>
1	Williams, Daugherty & Upham, Duluth, Minn.....	14½
2	Charles S. Barker, Duluth, Minn.....	14

Contract awarded to Charles S. Barker, with the approval of the Chief of Engineers.

Contract dated March 11, 1891; work to be completed by October 1, 1891.

COMMERCIAL STATISTICS, SUPERIOR, WISCONSIN.

Arrivals and clearances of vessels for 2 years.

Year.	Arrivals.	Clearances.	Total.	Tonnage.
1890	634	622	1, 256	1, 541, 777
1889			900	1, 122, 048
Increase			356	419, 729

Average vessel tonnage.

	Tons.
1890	1, 228
1889	1, 247
Decrease	19

Of the number of vessels reported above for 1890, 1,068 were steam and 188 sailing vessels.

The storage capacity of the Superior elevators is 8,300,000 bushels.

Shipments by lake of leading articles during the season of 1890.

	Tons.
Wheat.....	249, 288
Corn.....	40, 293
Oats.....	22, 062
Barley.....	883
Flour.....	138, 339
Total	450, 885

Receipts by lake for 1890.

Coal.....	1, 045, 000
Total of receipts and shipments	1, 495, 885

Comparative statement of receipts and shipments for 7 years.

Year.	Tons.	Year.	Tons.
1884	17,462	1888	327,327
1885	33,626	1889	1,006,542
1886	117,027	1890	1,495,835
1887	170,020		

Comparative statement of arrivals and clearances of vessels for 8 years.

Year.	Vessels.	Tonnage.	Year.	Vessels.	Tonnage.
1883	20	10,619	1887	462	404,780
1884	194	119,288	1888	812	915,816
1885	200	113,519	1889	900	1,122,048
1886	316	283,787	1890	1,256	1,541,777

K K 5.**IMPROVEMENT OF MINNESOTA POINT AT SUPERIOR, WISCONSIN.**

The approved project for this improvement consisted in building about 1,000 feet of sand fence near the old light-house on the southern extremity of the point to catch the drifting sand and prevent its blowing over into the Superior channel, which is very close to the shore of the point in this vicinity, and about 200 feet at a low and narrow part of the point, known as "The Opening," about 2 miles north of the old entrance, to form a bank which would prevent the lake from cutting through into the bay during storms.

The fences were built according to the plans published in House Ex. Doc. No. 51, Fifty-first Congress, first session.

Work was begun by the contractors shortly before the opening of navigation and final payment made May 31, 1891.

This work is in the collection district of Duluth, Minn. The nearest light-house is situated on the outer end of north pier of the Superior entry.

Money statement.

Amount appropriated by act approved September 19, 1890	\$4,895.00
June 30, 1891, amount expended during fiscal year	4,526.59
July 1, 1891, balance unexpended	368.41

Abstract of proposals received for constructing 1,210 linear feet of sand fences on Minnesota Point, near Duluth, Minn., opened at Duluth, Minn., February 27, 1891.

No.	Name and address of bidder.	Price bid per running foot.	Total.
1	William Z. Partello, Washington, D. C.	\$3.75	\$4,560.00
2	Henry P. Welland and John F. Schleunes, Duluth, Minn.	4.81	5,848.96
3	Angus W. Shaw and Edward Mahoney, Duluth, Minn.	5.49	6,675.84
4	Campbell & McDonald, Duluth, Minn.	3.45	4,195.20
5	Morrison & McGregor, Duluth, Minn.	3.95	4,803.20

Contract awarded to Campbell & McDonald with the approval of the Chief of Engineers.

Contract dated March 24, 1891; work to be completed August 30, 1891.

K K 6.

IMPROVEMENT OF HARBOR AT ASHLAND, WISCONSIN.

Ashland Harbor comprises a portion of Chequamegon Bay. It was not thoroughly protected from the storm-waves which rolled into the bay from its mouth or from the waves generated in the bay itself, and accordingly a revised project for a breakwater 8,000 feet long, so located in the bay as to give the requisite shelter, was approved February 9, 1889. Of this breakwater 4,650 feet were built during that season.

It was deemed to be rather flimsy, but has stood the buffeting of the storms and ice better than was anticipated. The slab filling settled considerably, but not much more than was to be expected, and 50 feet of the outer end was swept away by storms and ice.

Considering that the work is something of an experiment its success is quite flattering.

Much apprehension was felt that the crowding of the ice, due to the expansions incident to variations of temperature, would crush or displace this rather fragile construction, but these fears were not realized, and it is possible that this very ability of the structure to yield slightly to pressure has proved its safety. The repairs in progress at date of last Annual Report were completed in September last and at the opening of this season the breakwater was found to be in good condition.

Its length is hardly sufficient to give protection to all the wharves of the city, but its influence in diminishing the turbulence of the waters of the harbor is distinctly apparent. The contract now in progress will extend the breakwater 1,080 feet and close the breach in Chequamegon Point with a brush and stone dike. To build the remaining 2,320 feet of the breakwater, estimated at present contract prices, will cost \$94,000, including probable necessary repairs and contingencies.

A harbor line has been established by the city, but there is not a uniformity of depth along it. To give a channel 200 feet wide and 17 feet deep along this dock line about 425,000 cubic yards of material will have to be excavated. This will cost \$93,500, provided no rock is encountered.

An examination of the breach in Chequamegon Point was made in March, 1890, and the changes which have taken place since 1887 were determined as accurately as possible. The results of this examination, with estimates for a dam to close this opening, were submitted to the Chief of Engineers March, 15, 1890, approved, and the work included in the contract for this season.

The principal shipments from Ashland are iron ore and lumber.

There is an iron furnace and general machine shop in operation, and it is presumed that the other enterprises which are expected to locate here will materially increase the shipments of manufactured articles and general merchandise.

There has been expended during the year just closed \$17,451.24 and the total amount expended under approved project to date is \$77,737.80.

RECOMMENDATIONS.

For 2,320 feet extension to the breakwater.....	\$70,000
For repairs and contingencies	24,000
For dredging	93,500
Total	187,500

This work is in the collection district of Superior, Mich., Marquette, Mich., being the port of entry; nearest light-house, La Pointe, on Chequamegon Point, at entrance of Chequamegon Bay.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT ASHLAND, WISCONSIN.

By act of Congress approved August 5, 1886	\$22,500
By act of Congress of August 11, 1888	60,000
By act of Congress approved September 19, 1890	60,000
Total	142,500

Money statement.

July 1, 1890, balance unexpended	\$22,213.44
Amount appropriated by act approved September 19, 1890	60,000.00
	82,213.44
June 30, 1891, amount expended during fiscal year	17,451.24
July 1, 1891, balance unexpended	64,762.20
July 1, 1891, amount covered by uncompleted contracts	54,276.00
July 1, 1891, balance available	10,486.20
{ Amount (estimated) required for completion of existing project	187,500.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	100,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals received for constructing breakwater and building brush and stone dike at Ashland, Wis., opened at Duluth, Minn., February 12, 1891.

No.	Name and address of bidder.	Prices bid for breakwater, per running foot (1,260 feet).	Total.	Prices bid for brush and stone dike, per running foot (4,200 feet).	Total.
1	Truman & Cooper, Manitowoc, Wis.	\$29.30	\$36,918.00	\$11.00	\$46,200.00
2	Zimmerman, Truax & Co., Duluth, Minn.	35.49	44,717.00	6.31	26,502.00
3	Sang, Thomas & Sang, Duluth, Minn.	32.65	41,139.00		
4	Heidenreich Co., Chicago, Ill.	29.48	37,144.80		
5	Joseph Wolf, Duluth, Minn.	35.07	44,188.20	6.80	28,560.00
6	Davis & Ferguson, Ashland, Wis.	28.00	35,280.00		
7	Morrison & McGregor, Duluth, Minn.	37.00	46,620.00	7.25	30,450.00
8	Hugh Steele, Duluth, Minn.	25.95	32,697.00	6.25	26,250.00

Contract for constructing breakwater and brush and stone dike awarded to Hugh Steele with the approval of the Chief of Engineers.

Contract dated March 2, 1891; work to be completed by October 31, 1891.

COMMERCIAL STATISTICS, ASHLAND, WISCONSIN.

Arrivals and clearances of vessels for two years.

Year.	Arrivals.	Clearances.	Total.	Tonnage.
1890	2,240	2,240	4,489	2,750,000
1889			3,171	2,500,000
Increase			318	250,000

Average vessel tonnage.

1889	Tons. 788
1890	613
Decrease*	175

* Due to increase of sailing craft employed in the lumber trade.

2502 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Principal articles of export and import for 1890.

Exports—	Tons.
Iron ore	2, 083, 368
Pig iron	19, 000
Manufactured iron	13, 282
Ice	2, 077
Stone, building	3, 694
Lumber	168, 862
Shingles	1, 500
Lath	4, 250
Railroad ties	2, 008
Telegraph poles	1, 627
Posts	1, 161
Grain	36, 066
Flour	304
Total	2, 337, 219
Imports—	
Coal	459, 000
Iron and steel rails	7, 060
Salt	10, 186
Cement	3, 459
Total	479, 705
Total receipts and shipments for 1890	2, 816, 924

Comparative statement of receipts and shipments for four years.

	Tons.
1887	1, 401, 454
1888	1, 357, 472
1889	1, 971, 213
1890	2, 816, 924

Arrivals and clearances of vessels for four years.

	No.
1887	892
1888	2, 375
1889	3, 171
1890	4, 489

K K 7.

IMPROVEMENT OF HARBOR AT ONTONAGON, MICHIGAN.

In 1887 the Ontonagon River, which forms the harbor, had fairly deep water in it, but its mouth was obstructed by a bar which had but 7 feet depth over it. The project adopted then for the harbor it offered was to build parallel piers projecting into the lake on either side of the river's mouth, the expectation being that the current of the river would have sufficient force to maintain a depth between the piers of 12 feet or more. This expectation has not been fully realized, although the piers are nearly of the proposed length, the east pier being 2,315 feet in length and the west pier 2,675 feet.

It appears that the river, during the spring freshets, is heavily charged with sand, and the bar at the entrance forms as fast as the piers are extended. The channel which the river is able to maintain through this bar is shifting and uncertain.

Unless the piers can be speedily extended into deep water, which, owing to the gradual slope of the lake bottom and consequent great expense, is hardly practicable, it does not appear advisable to carry

the pier work any further at present. The improvement of the harbor can probably be more economically pursued by dredging a channel through the bar each year.

The portion of the piers composed of piling is very much decayed and needs replacing. This will cost \$15,600. The dredging will cost \$15,000 annually.

The contract now in progress will complete the superstructure, and a dredged channel through the bar has just been finished, together with some dredging between the piers.

The amount expended during the year was \$952.17.

The total cost of the improvement to June 30, 1891, was \$302,783.13.

As a result of the improvement there is just now a channel with least depth of 16 feet, but it is likely to shoal again. 24,488.8 cubic yards were excavated from the channel.

This work is in the collection district of Superior, Mich.; nearest port of entry, Marquette, Mich. A light is shown on the outer end of the west pier at Ontonagon, Mich.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT ONTONAGON, MICHIGAN.

By act of Congress—

Approved March 2, 1867	\$97,600
Approved July 7, 1870	10,000
Approved June 23, 1874	23,000
Approved March 3, 1875	25,000
Approved August 14, 1876	15,000
Approved June 18, 1878	15,000
Approved March 3, 1879	17,000
Approved June 14, 1880	15,000
Approved March 3, 1881	20,000
Passed August 2, 1882	20,000
Approved July 5, 1884	15,000
Approved August 5, 1886	13,000
Passed August 11, 1888	12,500
Approved September 19, 1890	10,000

Total 308,100

EXPENDITURES.

Amount expended under approved project to date \$302,783.13
 Balance available July 1, 1891 2,061.87

Estimated amount required annually for preserving and maintaining
 (dredging) 15,000.00
 Estimated amount required for repairing piers 15,600.00

Total 30,600.00

Money statement.

July 1, 1890, balance unexpended \$1,942.11
 Amount appropriated by act approved September 19, 1890 10,000.00

June 30, 1891, amount expended during fiscal year 11,942.11
 952.17

July 1, 1891, balance unexpended 10,989.94
 July 1, 1891, outstanding liabilities \$5,673.07
 July 1, 1891, amount covered by uncompleted contracts 3,255.00
 8,928.07

July 1, 1891, balance available 2,061.87

{ Amount (estimated) required for completion of existing project 55,670.00
 { Amount that can be profitably expended in fiscal year ending June 30, 1893 55,670.00
 { Submitted in compliance with requirements of sections 2 of river and
 harbor acts of 1866 and 1867.

2504 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of proposals received for building superstructure and for dredging at Ontonagon, Mich., opened at Duluth, Minn., December 22, 1890.

No.	Name and address of bidder.	Dredg- ing price per cubic yard.	Superstructure.	
			Price bid, per running foot.	Total.
1	A. & D. Sang, Duluth, Minn		\$21. 70	\$3, 255. 00
2	J. C. Morrison & Roderick McGregor, Duluth, Minn		22. 00	3, 300. 00
3	Williams, Daugherty & Upham, Duluth, Minn	\$0. 24½		

Contract for building superstructure awarded to A. & D. Sang, with the approval of the Chief of Engineers. Contract dated January 24, 1891; work to be finished by September 1, 1891.

Contract for dredging awarded to Williams, Daugherty & Upham, with the approval of the Chief of Engineers.

Contract dated February 2, 1891; dredging to be completed by August 1, 1891.

COMMERCIAL STATISTICS, ONTONAGON, MICHIGAN.

Not being able to obtain the statistics for the years 1889 and 1890, I append the statistics printed in Annual Report for the calendar year 1888.

Arrivals and clearances of vessels.

Year.	Arriv- als.	Clear- ances.	Tonnage.
1887	174	174	222, 000
1888	120	120	188, 100

Principal articles of export and import.

Articles.	1887.	1888.
Exports:	Tons.	Tons.
Lumber	28, 929	42, 858
Copper	119	143
Fish	140	12
General merchandise	200	98
Total	29, 388	43, 111
Imports:		
General merchandise	1, 600	1, 665
Grain	600	
Flour	504	
Meats	26	
Salt	47	
Coal	500	1, 050
Live stock		26
Dressed lumber		22
Total	3, 277	2, 768

K K 8.

IMPROVEMENT OF EAGLE HARBOR, MICHIGAN.

This harbor was improved in order to form one of the harbors of refuge for this shore of Lake Superior. The entrance to the small bay which forms the harbor was obstructed by a rock ledge having but 8½ feet of water over it at the shoalest part.

The project for its improvement was adopted in 1866, but was modified in succeeding years so that, as carried out, it provided for a channel through the rocky ledge 130 feet wide and 14 feet deep, marked by two guiding cribs, one on each side of the channel.

This work was completed in 1879 and appears to meet the present demands of commerce.

The amount expended to June 30, 1891, was \$94,513.67.

Nothing is required at present for the improvement or preservation of this harbor, as the funds available will probably be sufficient to keep the work in good condition for several years.

Modified estimate (see Report of Chief of Engineers, 1876, II, 328; 1877, I,

98; II, 845)..... \$97,000.00

Appropriated..... 97,000.00

Name of harbor, Eagle Harbor, Michigan; collection district, Superior, Mich.; nearest light-house, Eagle Harbor, Michigan.

Money statement.

July 1, 1890, balance unexpended	\$2,486.33
July 1, 1891, balance unexpended	2,486.33

COMMERCIAL STATISTICS, EAGLE HARBOR, MICHIGAN.

Not having been able to obtain commercial statistics for the years 1887, 1888, 1889, or 1890, I append those for the calendar year 1886:

	Tons.
Exports:	
Copper	1,200
Imports:	
Coal.....	15,000
Lumber	858
Total	17,058

K K 9.

IMPROVEMENT OF HARBOR AT MARQUETTE, MICHIGAN.

The project for the improvement of this harbor was adopted in 1868. It contemplated the erection of a breakwater composed of timber cribs ballasted with rock and extending from the shore into the bay a distance of 2,000 feet. This breakwater was completed, practically as proposed, in 1875.

In consequence of the increasing shipments of iron ore from this port the past few years, the area protected proved to be too small for the needs of the shipping engaged in this commerce. In fact, one of the largest ore docks is outside its shelter from the most dangerous storms.

The extension of the breakwater became necessary some time ago, and provision was made for the commencement of this extension in the river and harbor bill of August 11, 1888.

The contract under this appropriation was for 180 feet extension of the breakwater, but after getting all the embankment and cribs in place two of the latter were carried away by a severe storm, leaving as the net result of the season's work 180 feet of embankment and one crib 60 feet in length. Considerable damage was also done to the remainder of the pier.

There was much speculation as to the integrity of the riprap foundation, but examination made through the ice, and since, proves that it has suffered no injury. From this it appears that where there are no deflecting surfaces or obstructions reaching to or above the surface of the water there is but little force exerted by the waves at 14 feet depth.

The extension of the breakwater is in an exposed place, and it is useless to attempt to carry on work upon it during the stormy seasons of the year. There does not, however, appear to be any necessity for altering the plan of construction materially, for where the cribs and superstructure are finished the pier is sufficiently strong. As a precaution during the building, however, the cribs should be decked over with heavy timber as soon as filled with rock, as otherwise the rock is liable to be scooped out by the waves and the stability of the crib destroyed. This can be safely done in those cases like Marquette, where the cribs are set upon a substantial riprap foundation, as there would be but little chance for the ballast to escape, and even if some did escape the superstructure would not be affected, and therefore the stability of the whole structure would be preserved.

The contract now in progress calls for 120 feet of crib work and superstructure on the 120 feet of embankment from which the cribs were taken by the storm, and 120 feet of entirely new work, embankment, cribs, and superstructure, making a total extension of breakwater of 240 feet.

It appears that the extension of the breakwater is urgently needed, with the present condition of the commerce of this place, for I am informed that there was more time lost in loading vessels last year on account of the water being too rough for them to lie at the wharves than from rainy weather.

The estimated cost of the remaining 700 feet of extension, at present contract prices, is \$98,000 contingencies, etc., \$9,800; a total of \$107,800. In addition, probably not less than \$15,000 will be required for repairs to old work during the period of construction.

The superstructure of the portion of the breakwater commenced in 1866 and finished in 1875 has been extensively repaired, but is, nevertheless, not as secure as is to be desired. Much of the timber has already been in place several years longer than the usual life of timber in this climate, and the time is short, if it has not already arrived, when this timber work must be replaced by more permanent material.

A project for a concrete superstructure was prepared during the winter and was approved February 27, 1890. This superstructure is estimated to cost \$232,936.71, of which sum \$100,000 could be expended judiciously in 1 year.

Harbor lines were established by the honorable Secretary of War in January, 1889, and a reconsideration of the subject occurred upon the application of the Duluth, South Shore and Atlantic Railway Company. Pending the action of the honorable Secretary of War upon this new

motion, the railroad company extended the ore docks as prayed for in the petition. I am not advised as to the final action upon the railroad company's petition, but no complaints from interested citizens of Marquette, or from owners or masters of vessels visiting this port, have so far been received by me regarding these extensions beyond the harbor lines, from which it is to be inferred that the encroachment is rather viewed as advantageous to all concerned.

RECOMMENDATIONS FOR NEXT YEAR.

For pier extension	\$107, 800
For concrete superstructure to old work	100, 000
General repairs	15, 000
Total	222, 800

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT MARQUETTE, MICHIGAN.

By act of Congress approved—	
March 2, 1867 (allotment)	\$85, 000
April 10, 1869 (allotment)	26, 730
July 11, 1870	25, 000
March 3, 1871	60, 000
June 10, 1872	50, 000
March 3, 1873	15, 000
June 23, 1874	15, 800
March 3, 1875	15, 000
August 14, 1878	2, 000
June 18, 1878	2, 000
March 3, 1879	1, 500
June 14, 1880	1, 000
By act of Congress passed August 2, 1882	16, 000
By act of Congress approved—	
July 5, 1884	5, 000
August 5, 1886	10, 000
By act of August 11, 1888	25, 000
By act approved September 19, 1890	40, 000
Total	394, 230

Money statement.

July 1, 1890, balance unexpended	\$6, 800. 38
Amount appropriated by act approved September 19, 1890	40, 000. 00
	<hr/>
June 30, 1891, amount expended during fiscal year	46, 800. 38
	2, 340. 96
	<hr/>
July 1, 1891, balance unexpended	44, 459. 42
July 1, 1891, outstanding liabilities	\$100. 00
July 1, 1891, amount covered by uncompleted contracts	28, 080. 00
	<hr/>
	28, 180. 00
	<hr/>
July 1, 1891, balance available	16, 279. 42
	<hr/>
{ Amount (estimated) required for completion of existing project	355, 736. 71
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	222, 800. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

2508 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of proposals received for constructing 240 linear feet of breakwater at Marquette, Mich., and opened at Duluth, Minn., December 17, 1890.

No.	Name and address of bidder.	Price bid per running foot.			Total.
		For cribs, super-structure, and additional rip-rap for embankment.	For new embankment.	For cribs and superstructure.	
1	Charles Berner, Green Bay, Wis.....	\$64.00	\$70.00	\$70.00	\$28,080.00
2	J. C. Morrison and Roderick McGregor, Duluth, Minn.....	105.00	135.00	80.00	38,400.00
3	John H. Porter and David Sang, Duluth, Minn.....	109.70	84.90	85.30	34,588.00
4	Joseph Wolf, Duluth, Minn.....	97.93	85.50	87.93	32,563.20
5	John H. Gillett, Marquette, Mich.....	99.88	76.42	81.43	30,937.60
6	Daniel W. Powell, John Mitchell, and Edward Mitchell, Marquette, Mich.....	101.27	65.50	67.26	28,063.00
7	Jacob Zimmerman, H. H. Truax, and John A. Moore, Duluth, Minn.....	100.00	88.00	79.00	32,040.00

Contract awarded to Mr. Charles Berner, with the approval of the Chief of Engineers.

Contract dated January 21, 1891. Work to be completed by October 1, 1891.

COMMERCIAL STATISTICS, MARQUETTE, MICHIGAN.

Arrivals and clearances of vessels.

Arrivals	1,450
Clearances	1,450
Tonnage	3,077,566

Principal articles of export and import.

Exports:	Tons.
Iron ore.....	1,816,353
Pig iron.....	7,570
Lumber.....	29,560
General merchandise.....	4,587
Total	1,858,070

Imports:	Tons.
Coal.....	147,687
Limestone.....	4,912
Sandstone.....	9,709
Lumber.....	110
Brick.....	3,625
General merchandise.....	10,918
Total	176,961

Vessel tonnage.

Year.	Tonnage.	Average tonnage.
1890.....	3,077,566	2,122
1889.....	2,896,518	1,080
Increase	181,048	1,042

There have been no new lines of transportation established so far as known.

Arrivals and clearances of vessels for four years.

Year.	Arrivals.	Clearances.	Total.
1887	695	695	1,390
1888	654	654	1,308
1889	1,366	1,366	2,732
1890	1,450	1,450	2,900

Comparative statement of receipts and shipments for 4 years.

	Tons.
1887	894, 772
1888	932, 335
1889	1, 709, 913
1890	1, 535, 031

K K 10.

IMPROVEMENT OF HARBOR OF REFUGE AT GRAND MARAIS, MICHIGAN.

The harbor of Grand Marais, Mich., is only accessible for vessels drawing less than 9 feet. Once within the bay there is ample depth to float the largest vessels. As a harbor of refuge it is of pressing importance to the shipping navigating the lakes in this vicinity, as the many wrecks in its neighborhood bear mute witness.

The project for the improvement of this harbor was adopted in 1881, and has for its object the creation of a safe entrance into the bay for vessels of the largest size. The entrance channel is to be about 300 feet in width, protected by crib piers on either side. The west pier is now 1,406 feet long, including 100 feet of pile dike, and the east pier is 853 feet long, including 100 feet of pile dike.

A channel 150 feet wide and 17 feet deep was dredged out between the piers in 1889. As the sand was piled up between the piers at the inner ends to the height of the superstructures, it was not supposed that the dredged channel would remain open, but it was believed that while the waves and currents might level the sand between the piers and obliterate the channel no accessions of sand were anticipated. An examination was made in June, 1890, and compared with the survey made in 1888 showed considerable change. The sand had been leveled and distributed over a rather larger area than was expected, and, although no accession of sand appears to have occurred, the character of the bar and the condition of the shore at the inner ends of the piers would indicate that a large quantity of sand had been washed into the channel and afterwards washed out.

The storm of December 26, 1890, carried away the end of the west pier with its superstructure, lodging it between the piers near the inner end of the east pier. It is probably too badly damaged to be replaced, even if money were available for that purpose, and in its present position it will not interfere with the use of the channel to be dredged this season.

A more substantial form of protection at the inner ends of the piers than that originally constructed appeared essential, particularly for the east pier, as the water had cut through behind it.

One contract now in force is for building new shore end on east pier with protecting spurs on the exposed side, remodeling old shore ends,

and repairing outer ends of piers; authority has also been obtained for the expenditure of \$1,000 in repairing damages that occurred after the other work was advertised, and this will be done as soon as possible.

Another contract is for dredging about 146,000 cubic yards, and work under it is about beginning.

Although properly the dredging should have been delayed until the piers were finished, the pressing need of a channel of some kind into the harbor warranted the commencement of this work.

To complete the work according to the approved project, 400 feet remain to be added to the west and 900 feet to the east pier. If the extension of the piers continues with reasonable celerity, probably a channel dredged to full 17 feet will not be obliterated; but will preserve a depth sufficient to revive the commercial interests of this place, which are held in abeyance at present for lack of this essential.

Vast lumbering interests lie contiguous to this harbor, which would make it a shipping point in the event of there being a sufficient depth of water in the channel to accommodate the vessels engaged in such business, and I think that it would not be long, after obtaining a navigable channel into it, before the harbor would claim other distinctions than that of a harbor of refuge.

Original estimate (see Report of Chief of Engineers, 1881, page 2053) \$450,000
Appropriated 231,250

This work is in the collection district of Superior, Mich. Nearest light-house, Big Sable, Mich.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR OF REFUGE AT GRAND MARAIS, MICHIGAN.

By act of Congress—

Approved June 14, 1880	\$10,000
Approved March 3, 1881	20,000
Passed August 2, 1882	40,000
Approved July 5, 1884	35,000
Approved August 5, 1886	26,250
Of August 11, 1888	50,000
Approved September 19, 1890	50,000

Total 231,250

Money statement.

July 1, 1890, balance unexpended	\$1,726.92
Amount appropriated by act approved September 19, 1890	50,000.00

	51,726.92
June 30, 1891, amount expended during fiscal year	1,385.77

July 1, 1891, balance unexpended	50,341.15
July 1, 1891, outstanding liabilities	\$19.20
July 1, 1891, amount covered by uncompleted contracts	43,151.00
	43,170.20

July 1, 1891, balance available	7,170.95
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{ Amount (estimated) required for completion of existing project	218,750.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	100,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of June, 1866 and 1867.	

Abstract of proposals received for extending and remodeling shore ends and repairs to outer ends of canal piers, and dredging at Grand Marais, Mich., opened at Duluth, Minn., December 29, 1890.

No.	Name and address of bidder.	Dredging.	Pier work.				
			For repairing outer ends of canal piers. Prices bid in total.	For new shore piers and spurs. Prices bid per running foot.	Total.	For remodeling old shore piers. Prices bid per running foot.	Total prices bid for all pier work.
1	Joseph Wolf, Duluth, Minn.	<i>Cts.</i>	\$2,400	\$30.00	\$12,000	\$25.50	\$5,100
2	Alexander Sang and David Sang, Duluth, Minn.		2,180	35.25	14,100	32.00	6,400
3	Daniel W. Powell, John Mitchell, and Ed. Mitchell, Marquette, Mich.	24	2,800	38.50	15,400	29.00	5,800
4	Hugh Steele, Duluth, Minn.		1,500	28.75	11,500	26.50	5,300
5	Williams, Daugherty & Upham, Duluth, Minn.	17½					
6	Charles S. Barker, Duluth, Minn.	17					

Contract for pier work awarded to Hugh Steele, with the approval of the Chief of Engineers.

Contract dated February 7, 1891; work to be completed by October 31, 1891.

Contract for dredging awarded to Charles S. Barker with the approval of the Chief of Engineers.

Contract dated February 3, 1891; work to be completed by October 31, 1891.

COMMERCIAL STATISTICS, GRAND MARAIS, MICHIGAN.

Arrivals and clearances of vessels.

Vessels.	Number.	Tonnage.
Steamers.....	72	12,000
Sailing vessels.....	34	8,000
Total.....	106	20,000

Principal articles of export and import.

Exports:	Tons.
Fish.....	200
Logs and hewed timber.....	8,890
Imports:	
Hay and grain.....	105
General merchandise.....	210
Total.....	9,405

Receipts and shipments for four years.

1887.....	Tons.
1888.....	1,910
1889.....	6,270
1890.....	8,686
1890.....	9,405

Arrivals and clearances of vessels for four years.

Year.	Vessels.	Tonnage.	Year.	Vessels.	Tonnage.
1887	74	10,850	1889	101	12,000
1888	102	25,000	1890	108	20,000

So far as can be learned, no new lines of transportation have been established. There are (estimated) 200,000,000 feet of pine timber standing, of which this harbor is the natural outlet, but owing to the difficulty of shipping lumber from here on account of the incomplete state of the entrance, a logging railroad has been built from a point about 8 miles from the harbor to connect with the head waters of the Manistique River, and this timber is now by rail and river finding its way to Lake Michigan, while the mills at Grand Marais are standing idle for want of proper shipping facilities.

K K II.

PRELIMINARY EXAMINATION OF ALLOUEZ BAY, AT THE WEST END OF LAKE SUPERIOR; ALSO THE NEMADJI RIVER FOR A DISTANCE OF FOUR MILES ABOVE ITS MOUTH, WITH A VIEW OF DETERMINING THE BEST METHOD OF IMPROVING AND MAKING THEM AVAILABLE AS A PORTION OF THE HARBOR SYSTEM OF THE CITY OF SUPERIOR.

[Printed in House Ex. Doc. No. 40, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 3, 1890.

SIR: I have the honor to submit herewith the accompanying copy of report, dated October 14, 1890, by Maj. James B. Quinn, Corps of Engineers, giving results of preliminary examination of Allouez (Al-louez) Bay at the west end of Lake Superior, also the Nemadji River for a distance of 4 miles above its mouth, Wisconsin, with a view of determining the best method of improving and making them available as a portion of the harbor system of the city of Superior, made to comply with the provisions of the river and harbor act approved September 19, 1890.

Major Quinn is of the opinion that these localities are worthy of improvement. Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division, is of the opinion that Nemadji River is not, at the present time, worthy of improvement by the General Government to the extent proposed. I concur in the views of Colonel Poe.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

HON. REDFIELD PROCTOR,
Secretary of War.

REPORT OF MAJOR JAMES B. QUINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Duluth, Minn., October, 14, 1890.

GENERAL: In response to the instructions in letter from your office dated September 20, 1890, I have the honor to submit the following report upon the preliminary examination of the Allouez Bay and Nemadji River surveys:

In the bill as printed Allouez Bay is named, but it is evident that Allouez Bay is intended, the substitution of an *n* for a *u* in the spelling being an error which I presume is immaterial.

Allouez Bay is very shallow, and whatever improvement is made in it would be confined principally to the dredging of channels in front of the dock lines which may be established and such other channels as may be requisite to connect it with the navigable areas of Superior Bay. Its little depth has so far prevented any utilization of its shores for dockage purposes, and I am informed that several commercial interests are held in abeyance pending the construction of suitable channels in this bay.

The Nemadji River is navigable for tugs and vessels of light draft for a distance of about 4 miles from its mouth. Some brickyards are located upon it, and other manufacturing establishments are in course of construction. This river is rather turbulent during the spring freshets, and for some years back more or less dredging has been done on the bar at its mouth to maintain navigation between the river and Superior Bay, but aside from this no systematic project for its improvement has been devised.

In the absence of conclusive ocular evidence of the worthiness of improvement in the case of Allouez Bay and Nemadji River, I addressed a letter to the parties interested in having these localities improved and a copy of the letter received in response is inclosed.

I am of the opinion that in view of the contemplated commercial enterprises which the improvement of the Allouez Bay and Nemadji River will promote the improvement of these localities is worthy.

ESTIMATED COST OF SURVEY.

The contemplated survey embraces considerable territory and must, for the purposes contemplated, be made with considerable precision. Part of the work can best be done after the ice forms.

Including the office work about three months' time will be required to complete it, and it is estimated that it will cost, including contingencies, \$2,563.

Respectfully submitted.

JAMES B. QUINN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., October 21, 1890.

Respectfully forwarded to the office of the Chief of Engineers, with the following remarks, viz:

The importance of Nemadji River appears to be almost wholly prospective. In view of the fact that the approved harbor lines on the Superior City front of Superior Bay are now fully 4 miles in extent, and almost entirely open to occupation, it would seem that sufficient accommodation can readily be found there for all the commerce which will be developed for some years to come.

Although Nemadji River has no great depth at its mouth, yet the comparatively small amount of dredging required to render available the navigation of the river for smaller craft may be advisable; but bearing in mind the more pressing requirements of other localities, I am reluctantly driven to the conclusion that this river is not, at the present time, worthy of improvement by the General Government to the extent herein proposed, and I therefore recommend that this project be disapproved.

O. M. POE,
Colonel, Corps of Engineers,
Engineer Northwest Division.

LETTER FROM CHAMBER OF COMMERCE OF SUPERIOR, WISCONSIN.

CHAMBER OF COMMERCE,
Superior, Wis., October 7, 1890.

SIR: It is much to be hoped that you will find time and opportunity this fall to make the survey of Allouez Bay and Nemadji River, recently authorized by Congress in the river and harbor act. The necessity for the survey is amply recognized by Congress in the wording of the item, which, under the head of surveys, reads as follows:

"Allouez Bay, at the west end of Lake Superior, also the Nemadji River for a distance of 4 miles above its mouth, with a view of determining the best method of improving and making them available as a portion of the harbor system of the city of Superior."

One of the largest and most available divisions of the city of Superior, the eastern, lies mainly on Allouez Bay, and the Nemadji River courses through the heart of the city, as does the Chicago River through Chicago.

The commerce of the port of Superior is becoming so large and varied, the quantities of wheat, coal, lumber, and other commodities handled at this point now comparing favorably with such ports as Buffalo, Chicago, and Duluth, that the harbor area needs to be enlarged, and that, too, without delay.

The Northern Pacific, the Chicago, St. Paul, Minneapolis and Omaha, the Duluth, South Shore and Atlantic, the Wisconsin Central, and at least three other trunk railway lines, also the Superior Terminal and Belt Line Railway Company, have interests on these waters whose value to the railroads and to the public will be greatly enhanced by the proposed surveys and improvements. A company is organized to build the largest sawmill in the West, with capacious docks and shipping facilities, on Allouez Bay; also a flouring mill, having a capacity of 2,000 barrels per day, with necessary elevators, storehouses, wharves, etc. Two establishments for sawing and handling brownstone for building purposes on a large scale have locations on the Nemadji River, about 1 mile above its mouth, and two brickyards are in successful operation about 2 miles above its mouth; two similar yards are located about 5 miles up the stream, and would use its navigation if made available for large vessels; while about 4 miles up is the new town of South Superior, a manufacturing suburb of Superior, having to-day a population of about 1,000 persons, and growing rapidly, mainly supported at present by two large industrial establishments, the La Belle Wagon Works and the Webster Chair Company.

The business of South Superior alone warrants the speedy improvement of the Nemadji River from its mouth to a point 4 miles up the stream.

Several minor interests and industries using the navigation of these waters might also be mentioned.

The need of adding these waters to the available harbor area of Superior is very urgent, and the commencement of the work will be looked forward to with great interest by all concerned.

JAMES BARDON,
Chairman Harbor Committee, Chamber of Commerce of Superior.

Maj. JAMES B. QUINN,
Corps of Engineers, U. S. A.

K K 12.

ESTABLISHMENT OF HARBOR LINES AT DULUTH, MINNESOTA, BAY OF ST. LOUIS, SUPERIOR BAY, AND THE ADJACENT WATERS, MINNESOTA AND WISCONSIN.

We, the undersigned, who are citizens of Duluth and interested in the preservation of the harbor in the Bay of Duluth and in the Bay of St. Louis, respectfully represent that dock lines in the State of Minnesota have been established along Minnesota Point, along the mainland, along both sides of Rice Point, and along the Bay and River St. Louis, as is shown by the ordinances and act of legislature, copies of which are hereto attached * and to which reference is made.

That opposite these lines, in the State of Minnesota, other dock lines have been established, in the State of Wisconsin, leaving a channel of varying width between. The channel between Rice Point and Minnesota Point, as still left by the action of our common council between the dock lines, is 2,000 feet in width. In the Bay of St. Louis the extreme distance between the dock lines on opposite side, near Rice Point, is about 4,000 feet, and in passing westward the dock lines approach each other so that they are only a few hundred feet apart where the deep natural channel of the St. Louis Bay, near the draw in the St. Paul and Duluth Railway Company's bridge, is encountered. Large improvements in the way of dock building and dredging are constantly being carried on upon both sides of the Bay of St. Louis and in the Bay of Duluth, and it is extremely desirable that the General Government should take up the question of these dock lines and determine whether or not it will ratify the action taken by the local municipal authorities upon the subject, so that all improvements and expenditures of money hereafter to be made may not be disturbed on account of infringing upon the right and interests of navigation, as represented in the General Government. In the course of the various dredgings which are being carried on contractors are making a practice of depositing their dredgings in the midst of existing channels, so that it will have to be removed in the future improvements of the harbor at large expense. And we desire that the Government may investigate the question so as to take charge of that portion of the harbor outside the dock lines, with a view of protecting the same in the interests of navigation. Your petitioners, therefore, respectfully submit the subject for your consideration, and ask that immediate action may be taken in the premises. And your petitioners will ever pray.

S. A. THOMPSON,
Secretary Chamber of Commerce,
(and twenty others).

Hon. REDFIELD PROCTOR,
Secretary of War.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
July 22, 1890.

Respectfully submitted to the Secretary of War with the recommendation that the Board organized for the harbor lines at Portage Lake, Michigan, namely, Col. O. M. Poe, Maj. J. B. Quinn, and Capt. W. L.

* Not printed.

Marshall, Corps of Engineers, be also charged with the duty of reporting upon the harbor lines at Duluth, Bay of St. Louis, Superior Bay, and the adjacent waters.

If approved by the Secretary the necessary orders will be given the Board.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Third indorsement.]

WAR DEPARTMENT,
July 24, 1890.

*The recommendation of the Chief of Engineers is approved.

L. A. GRANT,
Acting Secretary of War.

REPORT OF BOARD OF ENGINEERS.

DULUTH, MINN, *August 23, 1890.*

GENERAL: The Board of Engineers constituted by Special Orders No. 40, Headquarters, Corps of Engineers, current series, assembled at Duluth, Minn., August 21, 1890, in accordance with Special Orders No. 46, Headquarters, Corps of Engineers, dated July 25, 1890, and proceeded to consider the location of the harbor lines required at Duluth, Minn., the Bay of St. Louis, Superior Bay, and the adjacent waters.

The Board examined the maps in the office of the engineer in charge of the district, and afterwards spent half a day in traversing the probable lines. The Board also considered the several municipal ordinances of Duluth and Superior providing for dock lines within the limits of their jurisdiction, and by the legislature of the State of Minnesota beyond the limits of Duluth. A tabular statement of these ordinances, etc., is hereto appended.

The views of the representatives of the several localities involved were invited and the Board was accompanied in the inspection of the dock lines prescribed by the municipal ordinances and legislative acts above referred to by Mr. C. F. Johnson, collector of customs of the port of Duluth, Maj. M. R. Baldwin, president of the Duluth Chamber of Commerce, and Mr. W. F. Street, the secretary of the Chamber of Commerce of Superior.

After due consideration of the questions involved the Board recommends that with some slight changes the harbor lines described by the municipal ordinances and legislative acts cited, and as hereinafter described and referred to the true meridian, be approved. The changes that the Board recommends are that to avoid encroaching upon the present navigable channel the harbor lines at the southerly end of Minnesota Point be so drawn that the junction of the last two courses shall be at the westerly corner of Willard Dock as it stands at this date, and that in the vicinity of Grassy Point the dock line of the Minnesota side of the channel shall be so established as not to reduce the width between the dock lines at any point to less than 600 feet.

The following description by courses and distances indicates the locations of the dock lines in accordance with the foregoing recommendations, and the map* hereto attached and submitted as part of this report exhibits the lines drawn to correspond with the description.

* Omitted.

DESCRIPTION.

Commencing at a point in the south face of the north pier of Duluth Canal, 260 feet west of west line of Lake avenue; thence northerly parallel with Lake avenue for a distance of about 950 feet; thence in a southwesterly direction about 3,235 feet to a point 90 feet west of west line of Ninth avenue west, this line being distant from the south line of Railroad street 998.6 feet on west line of Sixth avenue west, and 964.8 feet from south line of Railroad street on west line of Ninth avenue west; thence south on an angle of $53^{\circ} 59'$ to the left of the prolongation of the preceding line about 845 feet to the easterly corner of the Northern Pacific Railroad Company's dock; thence 1,408 feet in a southerly direction on a line towards (but not reaching) the intersection of the westerly line of Eighth street on Rice Point with the township line between Townships 49 and 50 north, of range 14 west; thence about 5,870 feet in a southeasterly direction parallel with and 2,530 feet from the east line of Garfield avenue, Rice Point, to a point 400 feet north of the north line of Walnut avenue prolonged; thence 565.7 feet with a deflection of 45 degrees to the right, to the north line of Walnut avenue prolonged according to the recorded plat of Duluth; thence 2,087 feet southwesterly along the north line of Walnut avenue and same prolonged; thence westerly to a point in the prolongation of the northerly line of Spruce avenue 229 feet southwesterly of the west line of Garfield avenue, Rice Point; thence westerly to a point in the prolongation of the northerly line of Pine avenue, 430 feet southwesterly of the west line of said Garfield avenue; thence westerly to a point in the prolongation of the center line of Lynn avenue, 1,350 feet southwesterly of the center line of said Garfield avenue; thence northwesterly parallel with said Garfield avenue to a point where the dividing line between lots 7 and 8 in Block G, Duluth proper, second division, if produced will intersect with the same; thence westerly at right angles, to a point where the westerly line of Twenty-second avenue west, if produced, will intersect the same; thence southeasterly on a line parallel with and about 2,108 feet distant from the westerly line of Garfield avenue, on Rice Point, to a point of intersection with the northerly line of Elm avenue prolonged; thence southwesterly to a point on the west line of Mountain avenue, Oneota, prolonged, distant 3,000 feet from the southwesterly corner of Oneota street (formerly First street) and Mountain avenue, Oneota; thence by true bearings south $4^{\circ} 51'$ east about 2,975 feet to a point on track center of the St. Paul and Duluth Short Line Bridge, 150 feet west of west end of draw span and making an angle with said track center of $84^{\circ} 50'$ reckoned to the north of the westerly direction of the track; thence continuing in same direction of south $4^{\circ} 51'$ east about 1,925 feet; thence south $23^{\circ} 54'$ west 915 feet, to a point 1,315 feet due west of the southwest corner of section 16, Township 49, Range 14 west; thence continuing in same direction of south $23^{\circ} 54'$ west 1,630 feet; thence south $83^{\circ} 2'$ west about 840 feet to the 8-foot curve of depth on northerly side of the natural deep-water channel of the St. Louis River; thence following this curve of depth up to a point in the southerly prolongation of the township line between townships 49 north, range 14 west, and 49 north, range 15 west, 3,220 feet south of the quarter-section corner, at west side of section 18, township 49, range 14 west, excepting that the dock line leaves the 8-foot curve of depth about 1,200 feet before reaching the above-described point on the township line, and proceeds in a direct line to said point.

Commencing at the southwesterly corner of the south pier of the Duluth Ship Canal; thence in a direct line to a point on the westerly line of Minnesota avenue, Upper Duluth, 300 feet southerly from the intersection of said westerly line of Minnesota avenue with the channel side of said south pier; thence in a direct line to a point on the westerly prolongation of the center line of Dundee street 1,480 feet westerly from the westerly line of St. Louis avenue; thence southerly parallel with, and 1,480 feet from, the said westerly line of St. Louis avenue, to the westerly prolongation of the center line of Pine street, said Pine street being the dividing line between Upper and Lower Duluth; thence southerly and parallel with and 1,480 feet westerly from the westerly line of said St. Louis avenue to a point on the prolongation of the southerly line of Lower Duluth, and 2,060 feet westerly from a stone monument which is situated on the easterly line of Lake avenue and 400 feet southerly from the southerly line of St. Charles street; thence on a line making an angle of about $10^{\circ} 30'$ to the easterly of a prolongation of the above line about 10,050 feet to a point, said point being 955 feet distant westerly from a granite monument planted near the center of Minnesota Point, about 9,840 feet southerly from the southerly line of Lower Duluth aforesaid; said granite monument being 35 feet easterly from the United States Lake Survey base line, and said 955 feet being measured in a direction having an angle of $90^{\circ} 12'$ with said base line, reckoned to the left of the northerly end of the latter; thence on a line making an angle of about $2^{\circ} 38'$ to the easterly of a prolongation of the above-described line about 5,290 feet to the westerly corner of Willard's Dock, as it stands at this date; thence on a line making an angle of about $16^{\circ} 8'$ to the easterly of a prolongation of the last-described line about 570 feet to a point, said point being

situated at a distance westerly of 48.6 feet, measured at right angles to said line from a certain sandstone monument set near the shore of Superior Bay and on the west line of the United States Government reservation on said Minnesota Point.

Commencing at a point in St. Louis Bay opposite Grassy Point, 575 feet north, 1° 1' east, and 400 feet north 88° 59' west, of the southwest corner of section 16, township 49, range 14 west; thence north 21° 1' east 1,030 feet; thence north 1° 1' east 630 feet; thence north 25° 29' west 629.35 feet to the center of railroad track of the St. Paul and Duluth Railroad Bridge, making an angle of 64° 12' with the latter; thence continuing in the same direction north 25° 29' west 670.65 feet; thence north 1° 1' east 1,780 feet; thence north 48° 46' east 700 feet; thence north 70° 12½ east 7,367.1 feet to the east line of the Lehigh Dock property and passing 57.3 feet north (on line of west face of dock produced) of the northwest corner of the Lehigh Dock; thence north 62° 16' east 1,164.55 feet to a point on the center line of track of the Northern Pacific Railroad Bridge 149.35 feet south of south end of the draw span of the Wisconsin draw, and making an angle of 61° 59' with track center; thence continuing in the same direction north 62° 16' east 737.05 feet to the northeast corner of the Omaha Dock (or nearly thereto); thence southeasterly, making an angle of 116° 1' with preceding line, up into Howard's Pocket for a distance of 4,300 feet.

Commencing again at the initial point of the description, namely, 575 feet north 1° 1' east, and 400 feet north 88° 59' west, of the southwest corner of section 16, township 49, range 14 west; thence south 23° 54' west 2,875 feet; thence south 83° 2' west about 1,550 feet to a point 600 feet southerly from the 8-foot curve of depth on the northerly side of the natural deep-water channel of the St. Louis River; thence following up said river parallel to and 600 feet from said 8-foot curve of depth to a point in the southerly prolongation of the township line between townships 49, range 14 west, and 49, range 15 west, 3,970 feet south of the quarter-section corner at west side of section 18, township 49, range 14 west, excepting that for the last 1,000 feet of the last-described course the dock line follows the 8-foot curve of depth on the southerly side of the natural deep-water channel of the St. Louis River.

Commencing at a point 533.7 feet east of the north quarter-section corner of section 14, township 49, range 14 west, in Douglas County, Wis., said point being also 155.3 feet distant from the center line of the Northern Pacific Railroad track, measured west therefrom on the north line of said section 14, township 49, range 14 west, from station 158 plus 95 of said railroad; thence by true bearings north 49° 5' west about 6,171 feet; thence north 3° 32' east 60.3 feet; thence north 56° 22' east 1,296.8 feet to a point, this point being 343 feet northwesterly from the northerly corner of the St. Paul and Pacific coal dock on Connor Point, as now constructed (August, 1890), and on the line of its northeasterly face produced; thence south 53° east about 3,895 feet to a point distant 1,005.9 feet, measured on a line drawn at right angles to and northeasterly from the center line of the Northern Pacific Railroad track on Connor Point, at Station 182 plus 29.3 of said railroad; thence south 44° 20' east about 18,700 feet to a point on the prolongation of the center line of Walker avenue, and 2,004 feet from the center line of West Second street, in the city of Superior, this last-mentioned course also passing about 1 foot outside of the fender piles on the northerly corner of the Northern Pacific Railroad Company's dock; thence north 70° 40' east 1,220 feet; thence tangent to the last-mentioned line easterly and southerly on a circular curve of 200 feet radius, 326 feet; thence southerly tangent to said circular curve 492 feet to the westerly shore of the Namadji River.

All of which is respectfully submitted.

O. M. POE,
Colonel, Corps of Engineers, etc.
JAMES B. QUINN,
Major, Corps of Engineers.
W. L. MARSHALL,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
September 5, 1890.

Respectfully submitted to the Secretary of War.

It being made manifest to the Secretary of War that the establishment of harbor lines is essential to the preservation and protection of

the harbor at Duluth, Bay of St. Louis, Superior Bay, and the adjacent waters, a Board of Engineers was constituted by Special Orders from Headquarters, Corps of Engineers, to consider and report upon this subject, and the report of the Board recommends for approval of the Secretary of War the harbor and dock lines described in the within report and delineated upon the accompanying chart.

It is recommended that the lines selected be approved, and that the Secretary place his approval both upon the report and the tracing submitted.

H. M. ADAMS,
Major, Corps of Engineers, in charge.

[Second indorsement.]

WAR DEPARTMENT,
September 8, 1890.

Approved.

L. A. GRANT,
Acting Secretary of War.

List of ordinances, etc., referring to the location of harbor lines at Duluth, Minn., the Bay of St. Louis, Superior Bay, and the adjacent waters.

	Date.	Locality.
By Duluth City or Village.....	Jan. 18, 1872	Main harbor.
	Apr. 3, 1872	Do.
	Mar. 8, 1873	East side Rices Point.
	Feb. 10, 1883	Rices Point, end and west side.
	July 22, 1884	End and west side Rices Point.
	Aug. 5, 1884	Do.
	Feb. 16, 1886	Do.
	May 8, 1886	Do.
	Dec. 23, 1886	East side Rices Point.
	Oct. 28, 1889	N. P. Dock, taking out angle.
By act of State legislature.....	July 16, 1890	West side Minnesota Point, south of canal.
By board of supervisors, Douglas County, Wis.	Feb. 25, 1887	North side St. Louis Bay and Grassy Point.
	Apr. 1, 1884	Superior Bay and around Connor Point.
By board of trustees, village of Superior, Wis.	Mar. —, 1889	South side of St. Louis Bay.

K K 13.

ESTABLISHMENT OF HARBOR LINES IN PORTAGE LAKE, MICHIGAN.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., June 30, 1890.

SIR: I have the honor to submit a copy of the act approved June 20, 1890, authorizing and directing the Secretary of War to establish new harbor lines in Portage Lake, and to recommend that a board of officers, Corps of Engineers, consisting of Col. O. M. Poe, Maj. J. B. Quinn, and Capt. W. L. Marshall, be constituted by order from this Office for the purpose of examining the subject, making such surveys as may be

necessary, and recommending to the Secretary of War the location of new harbor lines at the locality concerned.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

HON. REDFIELD PROCTOR,
Secretary of War.

[First indorsement.]

WAR DEPARTMENT,
July 1, 1890.

Approved.

By order of the Acting Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

LETTER OF THE CHIEF OF ENGINEERS.

[Printed in House Ex. Doc. No. 200, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 20, 1891.

SIR: The act of Congress approved June 20, 1890, authorizes and directs the Secretary of War to establish new harbor lines in Portage Lake, Houghton County, Mich., and section 17 of the river and harbor act approved September 19, 1890, directing certain examinations and surveys, provides for "resurvey and relocation of harbor line in Portage Lake, Houghton County, Mich., in conformity with the provisions of recent law."

A Board of Engineers was, by your authority, constituted to consider and report upon the question of the establishment of harbor lines at Portage Lake, and a report was submitted December 11, 1890, accompanied by a map showing new harbor lines recommended by the Board.

The report of the Board and the location of the harbor lines, as indicated on the map, were approved by the Assistant Secretary of War January 5, 1891, and I have now the honor to submit the accompanying copies of the report and map, with recommendation that they be transmitted to Congress, under the provisions of section 18 of the river and harbor act of September 19, 1890, which requires that reports in relation to the examinations and surveys directed be made to the House of Representatives.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

HON. REDFIELD PROCTOR,
Secretary of War.

REPORT OF BOARD OF ENGINEERS.

[Printed in House Ex. Doc. No. 200, Fifty-first Congress, second session.]

HOUGHTON, MICH., December 11, 1890.

GENERAL: The Board of Engineers, constituted by Special Orders No. 40, Headquarters, Corps of Engineers, U. S. Army, July 5, 1890, assembled at Houghton, Mich., at 10 a. m., December 10, and pro-

ceeded to consider the subject of the establishment of new harbor lines in Portage Lake, Houghton County, Mich., in accordance with the act of Congress approved June 20, 1890. Conformably to the instructions conveyed to the Board in the letter from the Chief of Engineers, addressed to the senior member of the Board, dated Office of the Chief of Engineers, Washington, D. C., July 7, 1890, the Board held a public meeting and listened to statements presented by such persons as were in attendance. It is only fair to state that the persons present represented mining and other business of the locality, but no one appeared to specially represent the navigation interests; though, of course, all were directly concerned in the commercial uses of the waters in question, including facilities for shipping the products of the vicinage and receiving the supplies, which must necessarily reach this point by water.

The Hon. Jay A. Hubbell, who has taken an active interest in the subject of harbor lines in this locality, addressed the Board at some length and assured it that he had received letters from the principal shipowners navigating these waters, in which it was expressly stated that a width of 500 feet generally, and even less at some places, for short distances, would answer all the requirements for safe navigation. In this opinion the board concurs, and in recommending the new harbor lines for approval they adopt this view, but have not found it necessary to reduce the width between the harbor lines at any point to 500 feet, and to facilitate the maneuvering of vessels within the harbors of Hancock and Houghton a width of about 1,100 feet between harbor lines is provided at the former and about 900 feet at the latter.

In adjusting these lines an effort has been made to preserve as broad a channel as possible without trespassing upon the existing condition of the property of riparian owners, and the Board has endeavored, as far as to them appeared practicable, to locate the new harbor lines "with a view of harmonizing all interests affected."

Straight lines have been adopted in view of the greater convenience in defining them. The harbor lines proposed are indicated in full red lines upon the accompanying map* of Portage Lake, in vicinity of Houghton and Hancock, Mich., from surveys made under the direction of Maj. J. B. Quinn, Corps of Engineers, in October and November, 1890, scale 400 feet to 1 inch.

In case these harbor lines be approved by the Secretary of War, it is recommended that Maj. J. B. Quinn, Corps of Engineers, be at once directed to have permanent marks placed, from which they may be accurately laid down at any future time and from which a description of them may be made by courses and distances, and the same engrossed upon the map above referred to.

The papers referred to the Board are herewith returned.

All of which is respectfully submitted.

O. M. POE,
Colonel, Corps of Engineers, etc.
JAMES B. QUINN,
Major, Corps of Engineers.
W. L. MARSHALL,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

*Not reprinted.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
January 2, 1891.

Respectfully submitted to the Secretary of War.

The Board of Engineers constituted by Special Orders No. 40, Headquarters Corps of Engineers, July 5, 1890, to consider the subject of the establishment of new harbor lines in Portage Lake, Houghton County, Mich., in accordance with the act of Congress approved June 20, 1890, submits the within report, and recommends for approval the harbor lines for Portage Lake indicated by full red lines on the accompanying map. In locating these lines the Board has endeavored, as far as practicable, to harmonize all the interests affected.

It is recommended that the lines selected be approved and that the Secretary place his approval both upon the report and upon the accompanying map.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

The within report is approved, and approval of the location of the harbor lines is indicated on the accompanying map.

L. A. GRANT,
Assistant Secretary of War.

WAR DEPARTMENT,
January 5, 1891.

K K 14.

RESURVEY AND RELOCATION OF HARBOR LINE IN PORTAGE LAKE,
HOUGHTON COUNTY, MICHIGAN.

This survey was made in October, November, and December, 1890, in accordance with an act of Congress approved June 20, 1890, for the use of the Board of Engineers convened to establish new harbor lines in Portage Lake. The recommendations of the Board were duly approved by the War Department, and in March last 20 stone monuments were set as reference points for the lines.

The description of the lines to be engrossed upon the map has not yet been made out owing to press of other work, but all necessary data are on file and this will be done as soon as possible.

APPENDIX L L.

IMPROVEMENT OF HARBORS ON WESTERN SHORE OF LAKE MICHIGAN
NORTH OF CHICAGO, ILLINOIS, AND OF FOX AND WISCONSIN, AND
MENOMONEE RIVERS, WISCONSIN.

REPORT OF MAJOR CHARLES E. L. B. DAVIS, CORPS OF ENGINEERS,
OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891.
WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|---|---|
| 1. Manistique Harbor, Michigan. | 12. Manitowoc Harbor, Wisconsin. |
| 2. Cedar River Harbor, Michigan. | 13. Sheboygan Harbor, Wisconsin. |
| 3. Menomonee Harbor, Michigan and Wisconsin. | 14. Port Washington Harbor, Wisconsin. |
| 4. Menomonee River, Michigan and Wisconsin. | 15. Harbor of refuge at Milwaukee Bay, Wisconsin. |
| 5. Oconto Harbor, Wisconsin. | 16. Milwaukee Harbor, Wisconsin. |
| 6. Pensaukee Harbor, Wisconsin. | 17. Racine Harbor, Wisconsin. |
| 7. Green Bay Harbor, Wisconsin. | 18. Kenosha Harbor, Wisconsin. |
| 8. Harbor of refuge at entrance of Sturgeon Bay Canal, Wisconsin. | 19. Waukegan Harbor, Illinois. |
| 9. Ahnapee Harbor, Wisconsin. | 20. Fox and Wisconsin rivers, Wisconsin. |
| 10. Kewaunee Harbor, Wisconsin. | 21. Operating and care of locks and dams on Fox River, Wisconsin. |
| 11. Two Rivers Harbor, Wisconsin. | |

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., July 7, 1891.

GENERAL: I have the honor to transmit herewith annual report for the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1891.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

L L 1.

IMPROVEMENT OF MANISTIQUE HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan into the mouth of the Manistique River, where the harbor of Manistique is situated.

Project.—The original project, adopted in 1880, provided for the excavation of about 20,000 cubic yards of material to complete a channel 150 feet wide and 12 feet deep between the piers constructed by local enterprise at the mouth of the Manistique River.

Present works.—No construction work was done by the United States Government.

Depth of water.—Originally there was a depth of 7 feet, which was increased to 10 feet before any appropriation had been made by the Government.

A survey made May 19, 1890, showed an available but tortuous channel of 13 feet for a width of 60 feet.

Operations during the fiscal year.—There were no operations during the fiscal year ending June 30, 1891.

Remarks and recommendations.—Five thousand dollars were appropriated in 1880 and \$1,000 in 1881. The only work done under these appropriations was the removal of 11,780 cubic yards of material in 1880, under a contract with the Chicago Lumbering Company.

In October, 1880, a survey of the harbor showed that the direction of the piers lay across the natural channel. The company which had built the piers and had also the contract for dredging found it necessary at this time to renew about 330 feet of the west pier which had been washed away. The superintendent of the company was notified by the officer in charge, Maj. H. M. Robert, that the pier lines would have to be rectified to conform to the natural channel. The company declined to comply with this demand, and their contract, which had been extended from December, 1880, to June 1, 1881, was annulled. There have been no operations at this harbor since, and no money is asked for its improvement.

Estimated cost (see Report of Chief of Engineers, 1880, page 1931).....	\$6,000
Appropriated	6,000

Money statement.

July 1, 1890, balance unexpended	\$2,845.76
June 30, 1891, amount expended during fiscal year	245.00
July 1, 1891, balance unexpended	2,600.76

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1890.

[Furnished by Mr. W. H. Hill, Superintendent Chicago Lumbering Company.]

Name of harbor, Manistique, Mich.; collection district, Superior, Mich.; nearest light-house, Poverty Island, Mich.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	Tons.	No.	Tons.
Steam.....	347	122,931	347	122,931
Sail.....	179	51,538	179	51,538
Total	526	174,709	526	174,709

Principal articles of export and import.

EXPORTS.

Article.	Quantity.	Article.	Quantity.
	<i>Tons.</i>		<i>Tons.</i>
Butter	9	Merchandise (general)	714
Flour	23	Oats	20
Hides	13½	Posts (fence)	111
Iron and steel	4	Potatoes	197
Lath	3,992	Shingles	1,455
Lime and cement	69		
Lumber	116,841	Total	123,448½

Total approximate value, \$1,160,000.

IMPORTS.

Article.	Quantity.	Article.	Quantity.
	<i>Tons.</i>		<i>Tons.</i>
Agricultural implements	21	Hogs	54
Apples	47	Iron and steel	362
Beans	29	Lime and cement	244
Beer	176	Merchandise (general)	13,854
Brick	240	Mill stuffs	431
Butter	47	Oats	497
Cattle	149	Oil	293
Cheese	6	Plaster (land)	3
Coal and coke	1,760	Pork and beef	134
Corn	60	Potatoes	35
Eggs	27	Salt	175
Fish	625	Sheep	10
Flour	309	Wagons and carriages	12
Furniture	37		
Hay	679	Total	20,317
Hides	1		

Total approximate value, \$450,000.

L L 2.

IMPROVEMENT OF CEDAR RIVER HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Green Bay into Cedar River, where the harbor of Cedar River is located.

Project.—The original project adopted, in 1883 provided for the construction of two parallel piers 200 feet apart, extending from the mouth of Cedar River to the 16-foot contour in Green Bay, and dredging a channel between them 14 feet deep; also removing an outer shoal by dredging to a depth of 15 feet.

A modification of this project, approved in 1884, provided for continuing the piers in a direct line with the part already built instead of at an angle, as originally proposed.

Present works.—Pile piers lined with sheet piling: (1) East pier, 754 feet in length, 16 feet wide; (2) West pier, 301 feet in length, 16 feet wide. All were built in 1883–1885, and are in good condition.

Depth of water.—Originally 8 to 10 feet, obstructed by a 3-foot bar in front of the mouth.

A survey made in May, 1890, showed the condition of the channel to be as follows: 13 feet deep, 20 feet wide; 12 feet deep, 40 feet wide, and 11 feet deep, 60 feet wide.

2526 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Operations during the fiscal year.—There have been no operations during the fiscal year ending June 30, 1891.

Remarks and recommendations.—Work was suspended at this harbor in November, 1885.

In view of the small amount of commerce likely to be benefited by its completion no appropriation for continuing the improvement has been recommended since 1885.

The Spalding Lumber Company states that a survey has been made for a railway between Spalding and Cedar River, connecting with the Chicago and Northwestern Railway at Spalding, and that it will undoubtedly be built during the year, and that it is also contemplated to build a charcoal furnace at this port in 1891.

These works will greatly increase the commercial importance of this harbor.

Original estimate (see Report of Chief of Engineers, 1882, page 2121)..... \$138, 000
Appropriated 30, 000

Money statement.

July 1, 1890, balance unexpended \$2, 288. 07
June 30, 1891, amount expended during fiscal year..... 70. 00
July 1, 1891, balance unexpended 2, 218. 07
{ Amount (estimated) required for completion of existing project 108, 000. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1890.

[Furnished by Spalding Lumber Company.]

Name of harbor, Cedar River, Mich.; collection district, Superior, Mich.; nearest light-house, on north-pier head, Cedar River Harbor, Michigan.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	Tons.	No.	Tons.
Steam	236	58, 750	236	58, 750
Sail.....	208	62, 140	208	62, 140
Total	444	120, 890	444	120, 890

Principal articles of export and import.

EXPORTS.

Article.	Quantity.	Article.	Quantity.
	Tons.		Tons.
Bark (tan)	208	Posts (fence)	2, 775
Fish.....	25	Shingles.....	1, 500
Hides.....	6½	Ties (railroad).....	14, 000
Lath.....	1, 375	Wood.....	5, 760
Lumber.....	87, 500		
Poles (telegraph).....	812	Total	63, 451½

Total approximate value, \$625, 000.

Principal articles of export and import—Continued.

IMPORTS.

Article.	Quantity.	Article.	Quantity.
	<i>Tons.</i>		<i>Tons.</i>
Apples	19	Lime and cement	19
Beer	101½	Oats	240
Brick	60	Oil	48
Cattle	60	Provisions	23½
Coal and coke	125	Salt	32
Corn	45	Sawlogs	6,000
Flour	180		
Hay	362	Total	7,320
Hogs	5		

Total approximate value, \$125,000.

LL 3.

IMPROVEMENT OF MEMOMONEE HARBOR, MICHIGAN AND WISCONSIN.

Object.—To secure a navigable channel from Green Bay into the Menomonee River, where the harbor of Menomonee is situated.

Project.—The original project adopted in 1871 provided for the construction of two parallel piers 400 feet apart, extending from the mouth of the river to the 15-foot contour in Green Bay, and dredging a channel between them 14 feet deep. In 1874 it was decided to extend the piers to the 16-foot contour.

Present works.—(1) North pier, 1,854 feet in length, consisting of 585 feet of slab pier 20 feet wide; 609 feet of pile pier, 481 feet of the same having a width of 14 feet and 128 feet a width of 18 feet; 660 feet of cribs, 610 feet with a width of 20 feet and 50 feet with a width of 24 feet. (2) South pier, 2,710 feet in length, consisting of 1,900 feet of pile pier, 1,804 feet having a width of 14 feet and 96 feet a width of 18 feet; and 810 feet of cribs 20 feet wide.

The pile piers were built in 1871–1874 and the cribs 1876–1884. The cribs are in good condition. The north pile pier was rebuilt above the water line in 1889, and is in good condition. The older part of the south pile pier is considerably decayed.

Depth of water.—Originally 4 feet. At the harbor entrance the depth varies from 16 to 18 feet and a channel between the piers from 200 to 300 in width, with a least depth of 14 feet, was completed in July, 1890.

Operations during the fiscal year.—Dredging by hired labor and the use of United States Dredge No. 1 was in progress at the beginning of the fiscal year.

It was continued until July 23, 1890, and the dredge then transferred to Sheboygan, Wis.

Fourteen thousand one hundred and seventy cubic yards of material were removed from the channel during the fiscal year.

Remarks and recommendations.—The full amount of the original estimate for the improvement of this harbor has been appropriated and the object sought is obtained.

The balance available from the appropriation made in 1888 is probably sufficient to maintain the channel and piers during the fiscal year ending June 30, 1893.

Original estimate (see Report of Chief of Engineers, 1874, Part I, page 139). \$212,000
 Appropriated 212,000

Money statement.

July 1, 1890, balance unexpended	\$5,083.23
June 30, 1891, amount expended during fiscal year.....	1,852.67
July 1, 1891, balance unexpended	3,230.56

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1890.

[Furnished by Mr. J. A. Van Cleave, mayor of Marinette, Wis., and Mr. Robt. S. Hutchinson, deputy collector of customs, Menomonee, Mich.]

Name of harbor, Menomonee, Michigan and Wisconsin; collection districts, Superior, Mich., and Milwaukee, Wis.; nearest light-house, Menomonee, Mich.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	Tons.	No.	Tons.
Steam	846	126,309	853	127,359
Sail	1,054	204,953	1,049	204,381
Total	1,900	331,262	1,902	331,740

Principal articles of export and import.

EXPORTS.

Articles.	Quantity.	Articles.	Quantity.
	<i>Tons.</i>		<i>Tons.</i>
Coal and coke	100	Pickets	488
Cranberries	13	Salt	105
Fish	551	Shingles	728
Lath	1,421	Wood	513
Lumber	637,088		
Merchandise (general)	50	Total	641,156
Paper	100		

IMPORTS.

	<i>Tons.</i>		<i>Tons.</i>
Apples	13	Merchandise (general)	3,000
Brick	500	Oats	264
Coal and coke	11,695	Salt	555
Fish	946	Shingles	243
Flour	355	Stone	11,550
Gravel	2,920	Wood	1,750
Hay	2,000		
Iron and steel	508	Total	37,188
Lime and cement	290		

L L 4.

IMPROVEMENT OF MENOMONEE RIVER, MICHIGAN AND WISCONSIN.

Object.—The formation of a channel 16 feet deep from Green Bay to N. Ludington & Co.'s mill, Wisconsin, a distance of about 2 miles.

Project.—The present approved project is for dredging a channel 24 feet wide and 16 feet deep from Green Bay up the Menomonee River as far as available funds will admit.

Present works.—The piers of the Menomonee Harbor improvement render construction works unnecessary for the Menomonee River improvement.

Depth of water.—Between the harbor piers the channel is from 200 to 300 feet wide and 14 feet deep, thence to N. Ludington & Co.'s mill, a distance of about 2 miles, it is narrow and intricate with a depth of about 13 feet.

Operations during fiscal year.—Under contract dated December 13, 1890, with Messrs. Truman & Cooper, of Manitowoc, Wis., for dredging 200,000 cubic yards, more or less, work was begun May 11, 1891, and at the close of the fiscal year 26,058 cubic yards had been removed.

By hired labor and purchase of materials in open market repairs were made to the dredging plant.

Remarks and recommendations.—In accordance with section 13 of the river and harbor act of August 11, 1888, and Department letter dated April 1, 1889, a survey was made of the Menomonee River in June and July, 1889, with a view to its improvement by the formation of a channel 200 feet wide and 16 feet deep from Green Bay to N. Ludington & Co.'s mill, a distance of about 2 miles.

A report of this survey, with map and estimate of cost of the proposed improvement, was made November 26, 1889, and published in House Ex. Doc. No. 34, Fifty-first Congress, first session.

For reasons stated in the report it was recommended that this dredging be left to be done by the local authorities and not by the United States Government.

By act of Congress approved September 19, 1890, \$54,000 were appropriated for "continuing the improvement up the river from the termination of old work," and the present approved project is to dredge the channel of 200 feet width and 16 feet depth from Green Bay up the Menomonee River as far as the \$54,000 will admit.

The contract now in force covers a section of the channel about 5,150 feet in length. The contractors placed one dredge on the work May 11, 1891, and propose to put on another about July 1.

It is also contemplated employing two Government dredges on the work, at points below and above the section under contract, the latter part of the present working season, and to resume work upon the same on the opening of navigation in 1892.

About half a mile below N. Ludington & Co.'s mill the riparian owners have placed on each side of the channel, and extending up the river nearly a quarter of a mile, rows of stone-filled cribs in front of the open reaches of the river called "log pockets," for the purpose of booming logs. These cribs lessen the width of the channel, and at the narrowest place are but 120 feet apart. To cut the channel to the full width of 200 feet would require the removal of all these cribs. The owners objected to their removal and thought the channel could be narrowed in this upper reach so as not to interfere with the cribs and still be wide enough for purposes of navigation. As this upper reach is composed of hard pan difficult and expensive to dig, it seemed to be in the interest of economy to lessen the width, and the following correspondence resulted from this state of affairs.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., May 25, 1891.

SIR: I am informed that yourself and others interested in the improvement of Menomonee River to obtain a channel 16 feet deep and 200 feet wide from Green Bay to N. Ludington & Co.'s mill would be satisfied, and probably prefer, a reduction in the width contemplated in the approved project for a portion of the distance, say from the easterly end of Hamilton & Merryman's warehouse to the upper end of the proposed improvement.

Will you please confer with parties interested and inform me what reduction in width of channel, if any, is desired, in order that I may, if necessary, submit a re-

2530 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

vised estimate of the funds required to complete the work in my Annual Report for the fiscal year ending June 30, 1891?

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major of Engineers.

HON. ISAAC STEPHENSON.

MARINETTE, WIS., June 2, 1891.

DEAR SIR: Yours of the 25th ultimo was duly received and contents noted.

I have seen parties interested, and the undersigned join with me in saying that we have considered your suggestion and think that there would be no objection made by anyone interested if reduction in width of channel should be made, as you suggest, "from the easterly end of Hamilton & Merryman's warehouse to the upper end of the proposed improvement," and would approve of reduction from that point to not less than 100 feet in width, with a depth of 16 feet, and we think it advisable to make the change.

Yours, respectfully,

ISAAC STEPHENSON,
N. LUDINGTON COMPANY,
By CALRB WILLIAMS, *Superintendent*,
The STEPHENSON MANUFACTURING COMPANY,
HAMILTON & MERRYMAN COMPANY,
By A. C. MERRYMAN, *Secretary*.

Maj. CHAS. E. L. B. DAVIS.

The original estimate for a channel 200 feet wide and 16 feet deep (see House Ex. Doc. No. 34, Fifty-first Congress, first session) was \$109,609.80. A revision of this estimate, reducing the width of the channel to 100 feet from the east end of Hamilton & Merryman's warehouse to N. Ludington & Co.'s mill, a distance of about 2,600 feet, would reduce the amount to \$74,500, leaving but \$20,500 to be appropriated to complete the work in accordance with the suggested modification in the width of the upper reach, which modified width is therefore recommended.

Money statement.

Amount appropriated by act approved September 19, 1890	\$54,000.00
June 30, 1891, amount expended during fiscal year	11,072.32
July 1, 1891, balance unexpended	42,927.68
July 1, 1891, outstanding liabilities	\$2,181.00
July 1, 1891, amount covered by uncompleted contracts	22,566.84
	24,747.84
July 1, 1891, balance available	18,179.84
{ Amount (estimated) required for completion of existing project	55,609.80
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	20,500.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for dredging Menomonee River, Michigan and Wisconsin, received in response to advertisement dated October 27, 1890, and opened November 25, 1890, by Maj. Charles E. L. B. Davis, Corps of Engineers.

Amount of appropriation available for this work, \$25,000.

Estimated amount of dredging in each section, 100,000 cubic yards.

No.	Name and residence of bidder.	Price per cubic yard.	
		Section A.	Section B.
		<i>Cents.</i>	<i>Cents.</i>
1	Horatio Truman and George Cooper, Manitowoc, Wis	10 1/2	11 1/2
2	S. O. Dixon, Racine, Wis	20	23
3	Williams, Dougherty & Upham, Duluth, Minn.	23	23
4	Carkin, Stickney & Cram, Saginaw, Mich	24	24
5	Green's Dredging Co., Chicago, Ill.	12 1/2	14 1/2
6	White & Finch, Grand Haven, Mich.	11 1/2	12 1/2
	Christopher H. Starke, Milwaukee, Wis	11 1/2	11 1/2
	Thapp & Gillen, Racine, Wis	14 1/2	15
	Green Bay Dredge and Pile Driver Co., Green Bay, Wis	15 1/2	15 1/2

With the approval of the Chief of Engineers a contract was entered into December 13, 1890, with Horatio Truman and George Cooper, the lowest responsible bidders, for this work.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1890.

The commercial statistics for the Menomonee River are the same as for Menomonee Harbor.

L L 5.

IMPROVEMENT OF OCONTO HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Green Bay up the Oconto River to the city of Oconto.

Project.—The original project, adopted in 1882, provided for the formation of a channel 100 feet wide and 8 feet deep by extending the slab pier built by the city to the 10-foot contour in Green Bay, and dredging between the piers and up the river to Section Street Bridge, a distance of about 2 miles, the piers to be parallel to each other and 150 feet apart.

Present works.—(1) North pier, 1,603 feet long, 20 feet wide. For 1,100 feet the piles are 5 feet apart; for the remaining 503 feet the piles are 4 feet apart on the channel side, and 2 feet apart on the outer side, the latter being provided with wale timbers, cross-ties and tie-rods. The filling is composed of slabs and edgings ballasted with sand. (2) South pier, 2,151 feet long, 20 feet wide. For 1,850 feet the piles are 5 feet apart, the remaining 351 feet is close piling. The filling is composed of slabs and edgings ballasted with sand, except the outer 301 feet, which is covered with 2 feet thickness of stone. (3) The outer side of the south pier, beginning 300 feet from the outer end for a distance of 1,000 feet, is protected from ice pressure by a line of close piling, thence shoreward for a distance of 850 feet by riprap. (4) Additional stability is given to 1,850 feet of the south pier by a line of piles on the channel side 3 feet apart, provided with wale timbers, cross-ties, and iron tie-rods at intervals of 9 feet.

These piers were built in 1882-'85. The south pier is in good condition. Sections 9 to 23, inclusive, of the north pier, a distance of 750 linear feet, were undermined by a freshet in April, 1891, and very seriously damaged by the filling settling in places to the water surface; the remainder of the pier is in fair condition.

Depth of water.—Originally 2 feet, increased to 3½ feet by local enterprise.

When dredging closed June 25, 1890, there was a depth of 10 feet at the entrance, thence to the upper end of Spies Slough, a distance of about 7,700 feet, there was a channel 8 feet in depth. This channel for a length of about 2,900 feet had a width of from 50 to 60 feet, and the remaining 4,800 feet a width of from 90 to 100 feet.

Soundings made in April, 1891, showed the governing depth at the entrance to be 7½ feet, and in the river 6½ feet.

Operations during the fiscal year.—There were no operations during the fiscal year ending June 30, 1891.

Remarks and recommendations.—It is not deemed advisable to refill, in its present condition, the portion of the north pier damaged by a freshet in April, 1891, as the piles are small, badly decayed, and have not sufficient penetration in the lake bottom.

2532 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

It will probably be necessary to drive a new line of piling for the channel face of the pier and protect its outer face with riprap.

To put it in good order will exhaust the available funds.

The detrimental effects to the channel in both river and harbor, due to the freshets that occur every spring, seem to indicate the necessity of providing some form of revetment to guide the current and protect the banks at various points in the river, if further improvement of the river is made.

This is provided for in the estimate submitted in 1883, as it was then anticipated that it might eventually become necessary.

For maintenance and preservation an appropriation of \$6,000 is recommended.

Estimated cost (see Report of Chief of Engineers, 1883, page 1646) \$150,000
Appropriated 68,000

Money statement.

July 1, 1890, balance unexpended	\$3,732.88
June 30, 1891, amount expended during fiscal year	767.75
July 1, 1891, balance unexpended.....	2,965.13
{ Amount (estimated) required for completion of existing project.....	82,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	6,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1890.

[Furnished by Mr. John Noonan.]

Name of harbor, Oconto, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Sherwood Point, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	Tons.	No.	Tons.
Steam	138	32,016	142	32,944

Principal articles of export and import.

EXPORTS.

Articles.	Quantity.
	Tons.
Fish.....	100
Lumber	90,000
Total	90,100

Total approximate value, \$725,000.

IMPORTS.

Articles.	Quantity.
	Tons.
Brick.....	1,000
Sawlogs	60,000
Total	61,000

Total approximate value, \$250,000.

L L 6.

IMPROVEMENT OF PENSACKEE HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Green Bay into the Pensaukee River.

Project.—The original project, adopted in 1883, provides for continuing a slab pier, which had been built by private enterprise, until it should reach the 10-foot contour in Green Bay, and dredging a channel south of it to a depth of 10 feet, and width of 100 feet, connecting the deep water in the river with the deep water in the bay.

Present works.—(1) A slab pier, 1,300 feet long and 20 feet wide, filled with slabs and edgings and ballasted with sand. It was built in 1883 and repaired in 1885. (2) One thousand six hundred feet of slab pier, built by private enterprise, was nearly all destroyed by a storm in 1885. The destruction of this work left the portion of the pier built by the United States a detached work.

Depth of water.—Originally 2 feet, increased by private enterprise to from 7 to 9 feet for a width of 30 feet. The destruction of the portion of the pier built by private enterprise by the storm of October, 1885, resulted in restoring the channel to about its original condition.

A survey made in May, 1890, showed the governing depth to be 2.8 feet.

Operations during the fiscal year.—There have been no operations at this harbor since the close of the season of 1885.

Remarks and recommendations.—There is no commerce at this harbor, and consequently no necessity for an appropriation for continuing the improvement.

The pier built by the United States was examined when the survey was made in May, 1890, and found to be in good condition.

Estimated cost (see Report of Chief of Engineers, 1883, page 1652).....	\$50,000
Appropriated	15,000

Money statement.

July 1, 1890, balance unexpended.....	\$3,801.26
June 30, 1891, amount expended during fiscal year	70.00

July 1, 1891, balance unexpended.....	3,731.26
{ Amount (estimated) required for completion of existing project	35,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

L L 7.

IMPROVEMENT OF GREEN BAY HARBOR, WISCONSIN.

Object.—To secure a more direct and deeper channel from Green Bay into the mouth of Fox River, where the harbor of Green Bay is located.

Project.—The original project, adopted in 1866, provided for dredging a channel 200 feet wide and 12 feet deep from the mouth of the Fox River, through Grassy Island to, the 12-foot contour in Green Bay, a distance of about 8,800 feet, and revetting some 650 feet of the same at Grassy Island. This project was completed in 1871.

A supplementary project, adopted in 1872, provided for straightening the channel and increasing its depth to 13 feet. In 1874 it was decided to increase the depth to 14 feet; this increased the length to about 10,600 feet.

Present works.—Revetments at Grassy Island. (1) West revetment, 620 feet long and 14 feet wide, with close piling on the channel side, and anchor piles about 5 feet apart on the outer side. The timber superstructure is 5 feet high. This revetment was built in 1870, rebuilt above water line in 1887, and is in good condition. (2) East revetment, 705 feet long and 14 to 17 feet wide, with close piling on the channel side, and on the bay side close piling for 425 feet, and for the remaining 280 feet piles about 5 feet apart. The timber superstructure is 7 feet high. This revetment was built in 1869, rebuilt above water line in 1885, and is in good condition.

Depth of water.—Originally a narrow and circuitous channel 6 feet in depth. In 1890 a central channel 150 feet wide and 14 feet deep was completed. The remaining 50 feet in width had a depth of from 12 to 13 feet; the dredging of this to 14 feet in depth is under contract and in progress.

Operations during the fiscal year.—Under the special agreement referred to in the Annual Report for 1890, with the Green Bay Dredge and Pile Driver Company, 20,000 cubic yards of material were removed from the channel. This work began July 1, and was completed September 5, 1890.

Under contract dated December 13, 1890, with Messrs. White & Finch, of Grand Haven, Mich., for dredging 36,000 cubic yards, more or less, to complete the channel for the full width contemplated, the work began May 9, 1891, and is in progress at the close of the fiscal year. To June 30, 1891, 9,737 cubic yards had been removed under this contract.

The pile protection at the north end of the east revetment at Grassy Island was renewed in September, 1890, at a cost of \$103.60, by hired labor and purchase of materials in open market.

Remarks and recommendations.—For the maintenance of the channel and preservation of the revetments at Grassy Island an appropriation of \$10,000 is recommended for the fiscal year ending June 30, 1893.

Estimated cost of present project (see Report of Chief of Engineers, 1881, page 2069)	\$135,000
Appropriated	125,000

Money statement.

July 1, 1890, balance unexpended	\$7,255.77
Amount appropriated by act approved September 19, 1890	10,000.00
	17,255.77
June 30, 1891, amount expended during fiscal year	7,030.97
	10,224.80
July 1, 1891, balance unexpended	818.96
July 1, 1891, outstanding liabilities	6,241.68
July 1, 1891, amount covered by uncompleted contracts	7,060.64
July 1, 1891, balance available	3,164.16
{ Amount (estimated) required for completion of existing project	10,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	10,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for dredging Green Bay Harbor, Wisconsin, received in response to advertisement dated October 27, 1890, and opened November 25, 1890, by Maj. Charles E. L. B. Davis, Corps of Engineers.

Amount of appropriation available for this work, \$7,000.
Estimated amount of dredging, 36,000 cubic yards.

No.	Name and residence of bidder.	Price per cubic yard.
		<i>Cents.</i>
1	White & Finch, Grand Haven, Mich	18
2	Green's Dredging Company, Chicago, Ill	35
3	Williams, Dougherty & Upham, Duluth, Minn	30
4	Christopher H. Starke, Milwaukee, Wis	25
5	Green Bay Dredge and Pile Driver Company, Green Bay, Wis	18½

With the approval of the Chief of Engineers, a contract was entered into December 13, 1890, with White & Finch, the lowest responsible bidders, for this work.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1890.

[Furnished by Mr. Chas. A. Hartung, deputy collector of customs.]

Name of harbor, Green Bay, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Grassy Island, Wisconsin.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	Tons.	No.	Tons.
Steam	414	124,042	410	126,086
Sail	297	51,155	334	46,239
Total	711	175,197	744	172,325

Increase of arrivals over 1889 142
Increase of departures over 1889 167

Principal articles of export and import.

EXPORTS.

Articles.	Quantity.	Articles.	Quantity.
	<i>Tons.</i>		<i>Tons.</i>
Barley	1,095	Malt	86
Beer	81	Merchandise (general)	2,614
Brick	3,591	Mineral water	7
Cattle	137	Mill stuffs	538
Coal and coke	104	Oats	4,232
Cooperage	404	Oil	17
Corn	36	Potatoes	105
Eggs	7	Rags	165
Fish	40	Rye	2,100
Flour	25,090	Salt	144
Hay	329	Sash, doors, and blinds	12
Hogs	17	Shingles	2,250
Horses	42	Wagons and carriages	9
Iron and steel	2,500	Wheat	1,372
Lime and cement	50		
Lumber	3,521	Total	50,595

Principal articles of export and import—Continued.

IMPORTS.

	Tons.		Tons.
Barley.....	88	Potatoes.....	77
Coal and coke.....	83,707	Pulp.....	57
Crockery.....	20	Pulp-wood.....	10,400
Fish.....	66	Salt.....	5,938
Horses.....	16	Shingles.....	332
Iron and steel.....	6,765	Shingle-bolts.....	897
Lime and cement.....	44	Stone.....	553
Lumber.....	3,032	Sugar.....	1,406
Merchandise (general).....	1,670	Wood.....	8,732
Oil.....	56		
Paper.....	313	Total.....	124,291
	60		

L L 8.

IMPROVEMENT OF HARBOR OF REFUGE AT ENTRANCE OF STURGEON BAY CANAL, WISCONSIN.

Object.—To form a harbor of refuge inclosing the Lake Michigan entrance to the Sturgeon Bay and Lake Michigan Ship Canal, and also afford a safe entrance to the canal in rough weather.

Project.—The original project was submitted in 1871 and adopted in 1873. It provided for the construction of converging piers inclosing a triangular area of about 10 acres, which was to be dredged out to the requirements of navigation at that time. The piers were about 1,200 feet long, 850 feet apart at the shore line, and 250 feet at the outer end.

Supplementary projects adopted in 1879 and 1880, provided for sheet-piling the pile piers, extending each pier 150 feet by detached works, so as to increase the width of entrance from 235 feet to 335 feet, and dredging to obtain at least 16 feet in depth over so much of the area of the basin as would be useful to vessels entering the harbor.

Present works.	Width.	North pier length.	South pier length.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>
Slab pier:			
Piles 4 feet apart.....	14	100	100
Close piling.....	14	150	150
Pile pier, close piling.....	14	512	512
Do.....	18	32	32
Crib pier.....	20	200	200
Do.....	24	200	200
Length of each main pier.....		1,194	1,194
Crib piers.....	24	100	100
Do.....	30	50	50
Length of each detached pier.....		150	150
Total length of each pier.....		1,344	1,344

Guide piling to connect main and detached piers, total.....	feet..	333
North slab and pile pier, sheet piled.....	do...	692
South slab and pile pier, sheet piled.....	do...	700
Material dredged.....	cubic yards...	139,822

The slab and pile piers were built in 1873-'74; the pile piers are in fair condition; the slab piers were rebuilt above the water line in 1889-'90. A small amount of stone filling is needed in the south pier.

The crib piers and guide piling were built in 1878-'84.

In April, 1891, an inspection of the work showed that the guide piling, built in 1881, was considerably decayed, and that the horns of the cribs that form the pierheads of the north and south piers were broken above and below the water surface. The damage to the piers was evidently caused by vessels striking when entering the harbor, and by the movement of ice floes. In other respects the cribs were in good condition.

Depth of water.—Soundings were made April 23, 1891, and at that date the depth at the entrance varied from 15 to 16 feet; thence to the canal the least depth was 13.1 feet. In April, 1890, the depth was 13.7 feet, indicating that a shoaling of 0.6 of a foot had occurred during the past year.

Operations during the fiscal year.—There were no operations during the fiscal year ending June 30, 1891.

Remarks and recommendations.—An estimate based on the survey made in April, 1891, indicates that the removal of 13,200 cubic yards of material is necessary to form a channel 120 feet wide and 16 feet deep.

It is contemplated to do this work, and make the necessary repairs to the pierheads, by hired labor and purchase of materials in open market during the present working season.

For the maintenance of the channel and piers an appropriation of \$5,000 is recommended for the fiscal year ending June 30, 1893.

Estimated cost (see Report of Chief of Engineers, 1874, Part 1, page 141)... \$180,000
Appropriated 168,000

Money statement.

July 1, 1890, balance unexpended.....	\$91.66
Amount appropriated by act approved September 19, 1890	3,000.00
	3,091.66
June 30, 1891, amount expended during fiscal year	66.31
July 1, 1891, balance unexpended.....	3,025.35
July 1, 1891, outstanding liabilities.....	70.00
July 1, 1891, balance available.....	2,955.35
{ Amount (estimated) required for completion of existing project	12,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	5,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1890.

[Furnished by Hon. E. S. Minor, Superintendent Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company, and Dr. Frank Mullen.]

Name of harbor, harbor of refuge at entrance of Sturgeon Bay Canal, Wisconsin; collection district, Milwaukee, Wis.; nearest light-house, on north pierhead, entrance to harbor.

Arrivals and departures of vessels.

Description.	Passages through the canal and harbor.	
	No.	Tons.
Steam	3,684	572,643
Sail	2,455	381,764
Total	6,139	954,407

Principal articles of export and import.

EXPORTS.

Articles.	Quantity.	Articles.	Quantity.
	<i>Tons.</i>		<i>Tons.</i>
Apples	7½	Lumber	270, 000
Bark (tan)	550	Mill stuffs	100
Barley	70½	Oats	10
Beans	6	Peas	750
Beer	105	Poles (telegraph)	68
Brick	380	Posts (fence)	37
Butter	7	Potatoes	120
Cattle	150	Rye	280
Cheese	5	Sheep	12
Eggs	45	Shingles	30, 000
Fish	300	Stonel.	280, 000
Flour	107½	Ties (railroad)	2, 650
Hay	600	Wheat	300
Hides	5	Wood	5, 000
Hogs	24	Wool	4
Lath	34, 375		
Lime and cement	2, 175	Total	628, 22½

IMPORTS.

	<i>Tons.</i>		<i>Tons.</i>
Agricultural implements	82½	Lime and cement	281
Apples	20	Merchandise (general)	3, 000
Barley	23½	Mill stuffs	100
Beans	6	Oil	225
Beer	70	Plaster (land)	100
Cattle	150	Pork and beef	24
Chairs	100	Provisions	5
Coal and coke	2, 000	Salt	6, 000
Flour	18	Sash, doors, and blinds	25
Furniture	238	Wagons and carriages	31
Hogs	48	Wooden ware	18
Iron and steel	600		
Leather	1½	Total	13, 142½

L L 9.

IMPROVEMENT OF AHNAPPEE HARBOR, WISCONSIN.

Object.—To secure a small artificial harbor for local purposes in the Ahnapee River with a navigable channel leading thereto from Lake Michigan.

Project.—The project of improvement adopted in 1875 provided for the formation of a small artificial harbor connected with the lake by a channel 100 feet wide and 12 feet deep, to be formed by the construction of two piers extending from the shore line to the 18-foot contour in the lake; also for blasting and dredging rock from the river bed near its mouth for a distance of 750 feet.

In accordance with a modification of the original project, approved September 27, 1884, the cribs sunk in extension of the piers have been placed 50 feet farther from the center line of the channel than the old piers, and will afford, when completed, a 200-foot entrance between the pierheads.

Present works.—(1) North pier, 1,102 feet in length, composed of 352 feet of pile pier, 320 feet of which is 14 feet wide and 32 feet 20 feet wide; also 750 feet of cribs 20 feet wide. (2) South pier, 1,125 feet in length, composed of 625 feet of pile pier 14 feet wide and 500 feet of cribs 20 feet wide.

The pile-piers were built in 1871-1874. The south pier was sheet piled in 1880; the north pier is not yet provided with sheet piling. The superstructure is considerably decayed and will soon require renewal; in other respects both piers are in good condition.

The crib piers were built in 1875-1889, and are in good condition.

Depth of water.—Originally 2 feet. Soundings made in November, 1890, showed a depth of water at the entrance of $16\frac{1}{2}$ feet, and a channel near the south pier about 60 feet wide, with a least depth of $11\frac{1}{2}$ feet.

One-third of the area from which rock has been excavated has the required depth of 12 feet; over the other two-thirds the average depth is about 9 feet.

Operations during the fiscal year.—By hired labor and purchase of materials in open market 200 linear feet of superstructure were built over cribs Nos. 12 to 15 of the north pier, and minor repairs were made to the south pier. This work was completed in November, 1890.

Remarks and recommendations.—To complete the project the following work is required: One hundred linear feet of cribs for extending each pier 50 feet; 200 linear feet of guide piling to connect the main and detached piers; 350 linear feet of sheet piling to the north pier; 30,000 cubic yards of dredging sand, clay, etc., and the removal of about 4,000 cubic yards of rock by drilling, blasting, and dredging.

It is contemplated expending the funds now available in sheet piling the north pier and dredging 20,000 cubic yards, more or less, of sand, etc.

There remains but \$9,000 unappropriated of the estimate submitted in 1875 for the completion of this work. This amount is insufficient, and will require an increase of \$10,000, or a total of \$19,000, for its completion.

This increase over the estimate submitted in 1875 is chiefly due to a breach that occurred at the inner end of the north pier that added largely to the quantity of sand dredging required, and to a seam in the rock at a depth of about 9 feet that rendered the blasting more difficult and expensive than was then anticipated.

Estimated cost (see Report of Chief of Engineers, 1876, Part II, pages 346-359; 1880, page 1910).....	\$175,000
Appropriated	166,000

Money statement.

July 1, 1890, balance unexpended	\$1,163.30
Amount appropriated by act approved September 19, 1890.....	6,000.00
	<hr/>
	7,163.30
June 30, 1891, amount expended during fiscal year	2,436.46
	<hr/>
July 1, 1891, balance unexpended	4,726.84
	<hr/>
{ Amount (estimated) required for completion of existing project.....	9,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	19,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1890.

[Furnished by Mr. M. T. Parker.]

Name of harbor, Ahnapee, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Kewaunee, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	Tons.	No.	Tons.
Steam.....	342	191, 375	341	191, 288
Sail.....	297	24, 622	293	24, 517
Total.....	639	215, 997	634	215, 805

Principal articles of export and import.

EXPORTS.

Articles.	Quantity.	Articles.	Quantity.
	<i>Tons.</i>		<i>Tons.</i>
Bark (tan).....	1, 100	Mill stuffs.....	70
Barley.....	188	Oats.....	320
Brick.....	200	Peas.....	3, 300
Butter.....	67½	Pork and beef.....	18
Cattle.....	600	Posts (fence).....	2, 775
Chairs.....	2½	Potatoes.....	300
Cheese.....	500	Rags.....	20
Clover seed.....	30	Rye.....	280
Eggs.....	75	Sheep.....	20
Fish.....	150	Shingles.....	750
Flour.....	215	Ties (railroad).....	5, 950
Furniture.....	9	Wheat.....	3, 600
Hay.....	1, 200	Wood.....	10, 000
Hides.....	25	Wool.....	10
Hogs.....	18		
Lumber.....	875	Total.....	32, 666

Total approximate value, \$450,000.

IMPORTS.

Article.	Quantity.	Article.	Quantity.
	<i>Tons.</i>		<i>Tons.</i>
Agricultural implements.....	500	Marble and granite.....	10
Apples.....	22½	Merchandise (general).....	3, 250
Barley.....	12	Mill stuffs.....	50
Beans.....	3	Oats.....	8
Beer and liquors.....	175	Oil.....	225
Cattle.....	30	Peas.....	6
Chairs.....	5	Plaster (land).....	165
Coal and coke.....	125	Pork and beef.....	6
Corn.....	28	Provisions.....	462½
Flour.....	537½	Salt.....	240
Furniture.....	22½	Sash, doors, and blinds.....	12½
Iron and steel.....	45	Sheep.....	2
Lath.....	206	Shingles.....	60
Leather.....	30	Wagons, carriages, and sleighs.....	250
Lime and cement.....	72½	Woodenware.....	4
Lumber.....	2, 250	Total.....	8, 915
Machinery (heavy).....	100		

Total approximate value, \$400,000.

L L 10.

IMPROVEMENT OF KEWAUNEE HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into the Kewaunee River where the harbor of Kewaunee is situated.

Project.—The project for the improvement of this harbor was adopted in 1881, and provides for the formation of a channel from a point about 2,000 feet south of the original mouth of the Kewaunee River through a spit of land about 300 feet wide, affording communication between the river and Lake Michigan. From the lake end of this cut two parallel

piers 200 feet apart are to be constructed, each 1,650 feet long, extending to the 18-foot contour. Between the piers and through the cut the channel is to be dredged to a depth of 14 feet.

Present works.—Pile piers lined with sheet piling: (1) The north pier is 1,000 feet long and 16 feet wide. (2) The south pier is 1,075 feet long and 16 feet wide. They were built in 1881–1889, and are in good condition.

Depth of water.—Originally 2 feet. Soundings made April 2, 1891, showed a channel about 40 feet wide, with a least depth of 11 feet. Since that date this has been increased to a depth of 14 feet and a width of 120 feet.

Operations during the fiscal year.—By hired labor and purchase of materials in open market, repairs were made to the dredging plant, and 32½ cords of stone were placed in the south pier at places where undue settlement had occurred.

From October 23, 1890, to June 29, 1891, United States Dredge No. 2 removed 77,790 cubic yards of material from the channel.

Under contract dated December 13, 1890, with Mr. John M. Borgman, of Kewaunee, Wis., for the construction of 300 linear feet of pile pier, work was begun May 15, 1891, and is in progress at the close of the fiscal year. The work is progressing favorably, and will probably be completed by September 15, 1891.

Remarks and recommendations.—The conditions of this place are unusually favorable for the construction and maintenance of an excellent harbor.

The approved project provided for the construction of 3,300 linear feet of pier; of this amount 2,075 linear feet are completed, and 300 linear feet under contract, to be completed on or before September 15, 1891.

The proposed railroad between Green Bay and Kewaunee, referred to in the last Annual Report, is in process of construction, and will probably be completed before the close of the present year.

This line will connect with a line of steamers to be established to ply between Kewaunee, Wis., and Manistee or Ludington, Mich., forming, in connection with existing railroad lines, a through route from the West to the seaboard, and will add materially to the importance of this harbor.

Should an appropriation be made for the fiscal year ending June 30, 1893, it is contemplated to expend it chiefly in pier construction. An appropriation of \$75,000 is recommended.

Estimated cost (see Report of Chief of Engineers, 1881, page 2084)	\$200,000.00
Appropriated by the United States	\$75,000.00
Appropriated by the local authorities	8,042.72
	<hr/> 83,042.72

Money statement.

July 1, 1890, balance unexpended	\$188.23
Amount appropriated by act approved September 19, 1890	20,000.00
	<hr/> 20,188.23
June 30, 1891, amount expended during fiscal year	9,107.77
	<hr/> 11,080.46
July 1, 1891, balance unexpended	11,080.46
July 1, 1891, amount covered by uncompleted contracts	10,000.00
	<hr/> 1,080.46
July 1, 1891, balance available	1,080.46

{ Amount (estimated) required for completion of existing project	116,957.28
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	75,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

2542 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of proposals for building 300 linear feet of pier extension at Kewaunee Harbor, Wisconsin, received in response to advertisement dated October 27, 1890, and opened November 25, 1890, by Maj. Chas. E. L. B. Davis, Corps of Engineers.

Amount of appropriation available for this work, \$10,000.

No.	Name and residence of bidder.	Round piles, per foot, 14, 5/8 linear feet.	Norway sheet piling, per M., 50, 400 feet, B. M.	White oak timber, per M., 19, 600 feet, B. M.	White pine timber, per linear foot, 12 by 12 inches, 532 linear feet.	White pine timber, per linear foot, 6 by 12 inches, 624 linear feet.	White pine plank, per M., 3, 600 feet, B. M.	Stone per cord, 700 cords	Screw bolts and tie-rods, per pound, 8, 500 pounds.	Spikes, per pound, 1, 000 pounds.	Total for 300 feet.
		<i>Cents.</i>			<i>Cents.</i>	<i>Cents.</i>			<i>Cents.</i>	<i>Cents.</i>	
1	Charles Simon, Two Rivers, Wis.	21	\$31	\$50.00	30	20	\$25	\$6.50	6	5	\$11,525.52
2	William Eugene Hutchinson, Menominee, Mich.	17	28	40.00	25	13	15	6.50	6	5	10,051.58
3	Horatio Truman and George Cooper, Manitowoc, Wis.	22	30	49.00	28	20	18	5.25	5	4	10,158.12
4	Halvor Johnson and Charles Dedrich, Mishicot, Manitowoc Co., Wis.	21	32	50.00	28	16	20	5.50	6	5	10,384.98
5	John B. Borgman, Kewaunee, Wis.	20	29	47.50	23	13	14	4.65	4½	4	9,239.58
6	Charles Berner, Green Bay, Wis.	20	30	50.00	30	20	20	5.25	5	5	9,914.00
7	Knapp & Gillen, Racine, Wis.	19	28	50.00	30	20	20	5.50	5½	5	9,908.17
8	Christian Schwarz, Fort Howard, Wis.	21	32	57.00	28	17	16	5.15	5	4½	10,221.38

With the approval of the Chief of Engineers a contract was entered into December 13, 1890, with John M. Borgman, the lowest responsible bidder, for this work.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1890.

[Furnished by Hon. W. Seyk, mayor of Kewaunee.]

Name of harbor, Kewaunee, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on north pierhead, Kewaunee, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	Tons.	No.	Tons.
Steam.....	373	194,082	373	194,082
Sail.....	213	13,423	212	13,360
Total.....	586	207,505	585	207,442

Principal articles of export and import.

EXPORTS.

Articles.	Quantity.	Articles.	Quantity.
	<i>Tons.</i>		<i>Tons.</i>
Bark (tan).....	1,320	Peas.....	3,300
Barley.....	235	Plaster (land).....	75
Brick.....	2,000	Pork and beef.....	5
Butter.....	90	Posts (fence).....	1,387
Cattle.....	150	Potatoes.....	60
Cheese.....	250	Rye.....	70
Eggs.....	24½	Shingles.....	225
Flax.....	45	Stone.....	7,000
Hay.....	1,000	Ties, (railroad).....	4,900
Hides.....	7½	Wheat.....	1,500
Lumber.....	2,000	Wood.....	2,400
Merchandise (general).....	1,500	Wool.....	1½
Mill stuffs.....	3,200		
Oats.....	65	Total.....	32,788½

Total approximate value, \$450,000.

IMPORTS.

Articles.	Quantity.	Articles.	Quantity.
	<i>Tons.</i>		<i>Tons.</i>
Apples.....	75	Merchandise (general).....	1,200
Beer.....	180	Oil.....	180
Chairs.....	3	Salt.....	270
Coal and coke.....	250	Sash, doors, and blinds.....	5
Corn.....	108	Shingles.....	45
Iron and steel.....	200	Wagons and carriages.....	12½
Lath.....	14	Wooden ware.....	2
Leather.....	12		
Lumber.....	210	Total.....	2,829
Malt.....	2½		

Total approximate value, \$300,000.

L L II.

IMPROVEMENT OF TWO RIVERS HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into Twin Rivers, where the harbor of Two Rivers is situated.

Project.—The project for the improvement of this harbor, adopted in 1870, provided for the construction of two parallel piers extending from the river mouth to the 18-foot contour in Lake Michigan, and dredging between them to a depth of 12 feet.

Present works.—Pile and crib piers: (1) North pier, 1,810 feet long, composed of 1,060 feet of pile pier 14 feet wide and 750 feet of cribs 20 feet wide. (2) South pier, 1,710 feet long, composed of 960 feet of pile pier 14 feet wide and 750 feet of cribs 20 feet wide. The pile piers were built in 1871-'74 and the cribs in 1875-'84. The latter are in good condition, but some filling and repairs will be required to the piling at an early date.

Depth of water.—Originally from 2 to 3 feet. In November, 1890, a channel 90 feet wide and 12 feet deep was completed. Soundings made in April, 1891, showed that at a point opposite the north shore line the

contour and obtaining a channel of not less than 14 feet depth at the shore line, increasing to 18 feet at the entrance. Pier extension under this project was completed in 1887, and the dredging in 1889.

In 1890 a project for an exterior breakwater 400 feet long was submitted.

Present works.—Crib piers: (1) North pier, 1,970 feet long, composed of 1,220 feet of cribs 20 feet wide and 750 feet 24 feet wide; (2) south pier, 1,900 feet long, composed of 1,150 feet of cribs 20 feet wide and 750 feet 24 feet wide.

Depth of water.—Originally 3 feet. A survey made April 11, 1891, showed a depth at the entrance of from 16½ to 18 feet, and a channel between the piers 70 feet wide and 14 feet deep; this was increased by dredging in May and June, 1891, to 75 feet wide and 16 feet deep.

Operations during the fiscal year.—Under contract dated December 13, 1890, with Messrs. Truman and Cooper, of Manitowoc, Wis., for rebuilding above the water line 600 linear feet, more or less, of the north pier, work was begun May 26, 1891.

On June 30, 1891, about 400 linear feet had been completed and the remainder was well under way.

Under a special agreement made April 23, 1891, with Messrs. Truman and Cooper, of Manitowoc, Wis., 9,464.3 cubic yards of material were removed from the channel by dredging.

By hired labor and purchase of materials in open market, 17.6 cords of stone were applied as riprap and filling of the south pier at places where undue settlement had occurred.

Remarks and recommendations.—The north pier was completed in 1885, and the south pier in 1887, and the dredging in 1889.

About 900 feet of the inshore superstructure is 20 years old or more. It is badly decayed and should be rebuilt above the water line without delay.

As stated in the last annual report, Manitowoc has a harbor of growing importance and the Government has expended up to date nearly \$300,000 in harbor improvements, which the rapid growth of the city has shown to be money wisely expended. Much complaint has been made from the very first of the difficulty experienced by vessels lying just inside of the harbor during northeast storms, and plans of exterior breakwaters have been suggested as far back as 1873. In 1886 a report was submitted to the Chief of Engineers by Captain Marshall on this subject. His opinion was that the river should be dredged inside beyond the bends of the river, that being the cheapest solution of the difficulty. Colonel Houston was also of the opinion that the proper place for the harbor was inside or beyond the river bends. Since then the combination of three railroads, the Lackawanna, the Lake Shore and Western, and the Flint and Pere Marquette, promises to bring about a great development of business at this point and gives this question of harbor protection additional importance.

In order to make this through route of transportation a success the Flint and Pere Marquette boats must run all winter, the same as the Grand Haven and Milwaukee boats. Experience with the latter line at Milwaukee has shown that the landing docks must be in the immediate vicinity of the lake and not a mile or more up a river, as would be the case at Manitowoc should an interior dredged harbor be insisted upon, for in the severe winters of that latitude it would be impossible to keep the river open and available.

It would therefore seem that some plan of exterior protection should be devised for this harbor. A crib work 400 feet long, built at an angle of about 45 degrees, with the line of direction of the piers and about

600 feet beyond the lake end of the north pier, promises good results and could be built for about \$40,000. In order to insure the best results this money should all be available at once and the entire breakwater, superstructure and all, built in one season, as a partially completed breakwater, without superstructure and lights, would be a dangerous obstruction.

The river and harbor act approved September 19, 1890, contained an appropriation of \$8,000 for this harbor, with the following proviso:

And the engineer in charge, with the approval of the Secretary of War, may use such part of the above appropriation in the construction of an outer breakwater as he may deem proper.

It was deemed advisable to expend the full amount of the appropriation for rebuilding superstructure and deepening the channel for the reason that this work was urgently needed, and the amount was too small to begin the construction of a breakwater.

For the preservation of the piers and maintenance of the channel an appropriation of \$8,000 is recommended for the fiscal year ending June 30, 1893, and for an exterior breakwater an appropriation of \$40,000 is recommended.

Estimated cost (see Report of Chief of Engineers, 1881, page 2064)	\$308, 182. 54
Additional estimate for a breakwater (see Report of Chief of Engineers, 1890, page 2345)	40, 000. 00
Total	348, 182. 54
Appropriated	307, 820. 00

Money statement.

July 1, 1890, balance unexpended	\$759. 61
Amount appropriated by act approved September 19, 1890	8, 000. 00
	8, 759. 61
June 30, 1891, amount expended during fiscal year	3, 694. 02
July 1, 1891, balance unexpended	5, 065. 59
July 1, 1891, outstanding liabilities	\$930. 93
July 1, 1891, amount covered by uncompleted contracts	3, 333. 64
	4, 264. 57
July 1, 1891, balance available	801. 02
{ Amount (estimated) required for completion of existing project	40, 362. 54
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	48, 000. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for building 600 linear feet of pier superstructure at Manitowoc Harbor, Wisconsin, received in response to advertisement dated October 27, 1890, and opened November 25, 1890, by Maj. Chas. E. L. B. Davis, Corps of Engineers.

Amount of appropriation available for the work, \$5,500.

No.	Name and residence of bidder.	White pine timber, per M. 12 by 12 inches, 150,000 feet B. M.	Pine plank per M., 3 by 12 inches, 5,760 feet B. M.	Stone, per cord, 50 cords.	Driftbolts, per pound 11,800 pounds.	Spikes, per pound, 300 pounds.	Total for 600 feet.
1	Horatio Truman, and George Cooper, Manitowoc, Wis.	\$27.00	\$19.00	\$6.00	Cents. 33	Cents. 4	\$1,884.44
2	Peter W. Galloway, Racine, Wis.	29.50	22.00	10.75	34	5	5,576.22

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With the approval of the Chief of Engineers, a contract was entered into December 13, 1890, with Horatio Truman and George Cooper, the lowest responsible bidders, for this work.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1890.

[Furnished by Mr. Frederick Schuette.]

Name of harbor, Manitowoc, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Manitowoc, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	Tons.	No.	Tons.
Steam	738	350, 219	742	360, 310
Sail	250	56, 280	256	56, 007
Total	988	415, 499	998	416, 317

Principal articles of export and import.

EXPORTS.

Articles.	Quantity.	Articles.	Quantity.
	<i>Tons.</i>		<i>Tons.</i>
Agricultural implements	250	Malt	45
Barley	704	Merchandise (general)	252
Brick	1, 200	Mill stuffs	5, 000
Butter	75	Oats	1, 205
Cheese	1, 750	Peas	7, 280
Corn	41	Potatoes	900
Eggs	120	Rye	264
Flour	36, 012½	Shingles	105
Furniture	9, 022½	Wheat	2, 250
Hay	2, 500	Wool	10
Leather	250		
Lumber	2, 712½	Total	71, 395

Total approximate value, \$2,797,000.

IMPORTS.

Articles.	Quantity.	Articles.	Quantity.
	<i>Tons.</i>		<i>Tons.</i>
Agricultural implements	144	Sawlogs	15, 000
Coal and coke	102, 339	Shingles	247
Iron and steel	625	Stone	4, 875
Lath	165	Wagons and carriages	50
Lumber	4, 025	Wood	7, 750
Merchandise (general)	3, 495		
Oil	225	Total	141, 610
Salt	2, 670		

Total approximate value, \$1,045,000.

L L 13.

IMPROVEMENT OF SHEBOYGAN HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into the harbor of Sheboygan at the mouth of Sheboygan River.

Project.—The project for the improvement of this harbor was adopted in 1852, and had for its object the formation of a 12-foot channel entrance to the mouth of the Sheboygan River. This was modified in 1873 so as to secure a deeper channel by further pier extension and dredging. Both projects were completed within their estimated cost, and a channel was formed 100 feet wide, with a depth of 15 to 16 feet between the piers. A survey made in 1880 showed a depth of less than 12 feet between the piers and on the outer bar. The existing project was adopted in 1881, its object being to deepen the channel still further by extending the piers to the 20-foot contour in the lake, and dredging to a depth of 18 feet between their outer ends, the depth decreasing to 14 feet at the shore line.

Present work.—Pile and crib piers. (1) North pier, 2,044 feet long, composed of 900 feet of pile and crib pier, built by the city, from 12 to 20 feet wide; 1,094 feet of cribs 20 feet wide, and 50 feet of cribs 30 feet wide. (2) South pier, 2,460 feet long, composed of 780 feet of pile and crib pier, built by the city, from 12 to 20 feet wide; 132 feet of pile pier 20 feet wide, 1,298 feet of cribs 20 feet wide, and 50 feet of cribs 30 feet wide, built 1852–1887. About 700 feet of the north pier and 900 feet of the south pier built since 1871 are in good condition, the cribs having been sunk on a stone or pile foundation. Previous to 1871 they were sunk on the natural lake bottom, composed of shifting sand, causing them to settle very unevenly.

Depth of Water.—Originally 4 feet. A survey made April 7 and 8, 1891, showed a channel about 50 feet wide, with a least depth of 14.3 feet.

Operations during the fiscal year.—By hired labor and the use of Government dredges Nos. 1 and 2, 25,325 cubic yards of material were removed from the channel.

By purchase of materials in open market 62.1 cords of stone were used for riprap and refilling the south pier.

A contract dated December 13, 1890, was entered into with Messrs. Truman and Cooper, of Manitowoc, Wis., for the extension of the north pier 150 feet by the construction of 3 cribs, each 50 feet long and 20 feet wide.

Remarks and recommendations.—It is expected that work under the contract dated December 13, 1890, will begin early in July, and be completed by September 1, 1891, the date that the contract expires.

The formation of a channel of navigable width 16 feet deep is in progress at the close of the fiscal year, and will probably be completed by August 1, 1891.

A channel of less depth than 16 feet does not meet the present requirements of the commerce of this harbor.

Should an appropriation be made for the fiscal year ending June 30, 1893, it is proposed to expend it in pier extension and such dredging and repairs as may be necessary for the maintenance of the channel and piers. An appropriation of 67,000 is recommended.

Estimated cost (see Report of Chief of Engineers, 1881, page 2104)..... \$150,000
Additional estimate (see Report of Chief of Engineers, 1884, page 1856).... 45,000

Total 195,000
Appropriated 128,000

Money statement.

July 1, 1890, balance unexpended	\$1,230.89
Amount appropriated by act approved September 19, 1890	15,000.00
	<hr/> 16,230.89
June 30, 1891, amount expended during fiscal year	3,705.46
	<hr/> 12,525.43
July 1, 1891, balance unexpended	12,525.43
July 1, 1891, amount covered by uncompleted contracts	10,000.00
	<hr/> 2,525.43
{ Amount (estimated) required for completion of existing project	67,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	67,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for building 150 linear feet of pier extension at Sheboygan Harbor, Wisconsin, received in response to advertisement dated October 27, 1890, and opened November 25, 1890, by Maj. Charles E. L. B. Davis, Corps of Engineers.

Amount of appropriation available for this work, \$10,000.

No.	Name and residence of bidder.	Pine timber per M, 90,000 feet, B. M.	Hemlock timber per M, 101,016 feet, B. M.	Pine plank per M, 9,000 feet, B. M.	Stone per cord, 600 cords.	Drift bolts per pound, 12,600 pounds.	Screw bolts per pound, 3,500 pounds.	Spikes per pound, 330 pounds.	Piles each, No. 72.	Total for 150 feet.
						<i>Cts.</i>	<i>Cts.</i>	<i>Cts.</i>		
1	Horatio Truman and George Cooper, Manitowoc, Wis	\$25	\$22.00	\$18	\$6.50	3	4	4	\$11.50	\$9,893.55
2	Charles Berner, Green Bay, Wis.	26	22.00	20	7.00	3½	4½	4½	11.00	10,347.70
3	Christopher H. Starke, Milwau- kee, Wis	30	22.00	24	8.00	4	6	6	16.00	11,824.15
4	Knapp & Gillen, Racine, Wis ...	27	22.50	20	7.50	4	5	5	10.00	10,798.36

With the approval of the Chief of Engineers a contract was entered into December 13, 1890, with Horatio Truman and George Cooper, the lowest responsible bidders for this work.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1890.

[Furnished by Col. J. A. Watrous, collector of customs, Milwaukee, Wis.]

Name of harbor, Sheboygan, Wis. Collection district, Milwaukee, Wis. Near-
est light-house, Sheboygan, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	Tons.	No.	Tons.
Steam	529	506,922	570	542,324
Sail	572		564	
Total	1,101	506,922	1,134	542,324

NOTE.—Repeated but unsuccessful efforts were made to obtain a statement of the principal articles of export and import at this harbor.

L L 14.

IMPROVEMENT OF PORT WASHINGTON HARBOR, WISCONSIN.

Object.—To secure a navigable channel entrance from Lake Michigan to a small artificial harbor formed by excavating two interior connected basins.

Project.—The original project for the improvement of this harbor was adopted in 1869, and provided for the building of two parallel piers extending from the shore-line to 10 feet of water in the lake, and the excavation of a basin 600 feet long by 200 feet wide inside of the shore line. In 1870 a deflection of about 10 degrees to the southward was made in the direction of the piers, this being considered a more favorable direction for their alignment. In 1876 a further modification of the plan was made by excavating a second basin to the northward and nearly at right angles to the first basin, and extending the piers to the 14-foot contour in the lake. This doubled the available area of the harbor and reduced the height of the entering waves very materially.

This is the project now being carried out. The two interior basins have a combined area of about $5\frac{3}{4}$ acres and are to be dredged to a depth of 12 feet, with a channel of the same depth connecting them with the lake, the channel inclosed between two piers 150 feet apart extending out to 14 feet of water.

Present works.—(1) North pier, 920 feet long, composed of 370 feet of cribs 14 feet wide, 500 feet 20 feet wide, and 50 feet 24 feet wide. (2) South pier, 1,226 feet long, composed of 370 feet of cribs 14 feet wide, 450 feet 20 feet wide, and 406 feet of pile revetment. The piers were built 1871-1887 and are in fair condition.

Depth of water.—At the mouth of Sauk River originally about 1 foot. A survey made September 5, 1890, showed the existence of a channel from the entrance to the inner end of the north pier about 12 feet deep and 80 feet wide.

The north basin has the required depth of 12 feet over nearly all its area. From abreast of the inner end of the north pier to the upper end of the west basin the average depth does not exceed 8 feet, although there is a narrow channel 12 feet deep.

Operations during the fiscal year.—By hired labor and the use of United States dredge No. 2, 9,485 cubic yards of material were removed from the entrance channel and basins. Work closed August 27, 1890.

Remarks and recommendations.—The north pier is built the full length contemplated.

To complete the project requires an extension of 100 feet of the south pier and the removal of about 20,000 cubic yards of material.

It was anticipated at the date of the last annual report that all the dredging required could be completed in 1890, but the exceedingly hard character of the material to be removed caused frequent breakdowns of the dredge, and not as much was accomplished as was then anticipated.

It is proposed to transfer a Government dredge from Sheboygan to this harbor in August, 1891, and complete the dredging this season with funds now available, and to make minor repairs to the piers while dredging is in progress.

Of the existing estimates for the completion of this work there remains unappropriated but \$4,027.17. This sum will not be sufficient to build the necessary 100 linear feet of crib extension to the south pier, contemplated in the approved project. This extension will cost \$6,500.

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The estimate therefore requires an increase of \$2,472.83, or an appropriation of \$6,500 to complete the work.

Estimated cost (see Report of Chief of Engineers, 1877, page 866)..... \$154,527.17
Additional estimate (see Report of Chief of Engineers, 1880, page 1922) 27,000.00

Total 181,527.17
Appropriated 177,500.00

Money statement.

July 1, 1890, balance unexpended \$2,038.95
Amount appropriated by act approved September 19, 1890 3,000.00

June 30, 1891, amount expended during fiscal year 5,038.95
2,004.25

July 1, 1891, balance unexpended 3,034.70

{ Amount (estimated) required for completion of existing project 4,027.17
Amount that can be profitably expended in fiscal year ending June 30, 1893 6,500.00
Submitted in compliance with requirements of sections 2 of river and
harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1890.

[Furnished by Mr. James McCarthy, harbor master.]

Name of harbor, Port Washington, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on outer end of north harbor pier, Port Washington, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	Tons.	No.	Tons.
Steam	56	4,940	55	4,830
Sail	105	8,410	105	8,410
Total	161	13,350	160	13,240

Principal articles of export and import.

EXPORTS.

Articles.	Quantity.	Articles.	Quantity.
	<i>Tons.</i>		<i>Tons.</i>
Apples	37½	Lumber	3,750
Barley	329	Malt	450
Beans	30	Merchandise (general)	700
Beer	210	Mill stuffs	360
Brick	2,400	Oats	100
Butter	35	Pork and beef	3½
Chairs	600	Potatoes	600
Cheese	70	Provisions	20
Corn	168	Shingles	420
Eggs	112	Stone	140
Fish	30	Wagons and carriages	12½
Flour	1,505½	Wheat	210
Hay	200	Wooden ware	55
Lath	41		
Leather	280	Total	12,929

Total approximate value, \$583,050.

Principal articles of export and import—Continued.

IMPORTS.

Articles.	Quantity.	Articles.	Quantity.
	<i>Tons.</i>		<i>Tons.</i>
Apples	22½	Lumber	6,120
Bark (tan)	1,320	Merchandise (general)	1,100
Barley	2,540	Oil	293
Beer	35	Provisions	70
Coal and coke	3,600	Salt	525
Corn	196	Saw logs	750
Fish	45	Shingles	450
Flour	11	Wagons and carriages	9
Hides	600	Wheat	1,050
Iron and steel	77½	Wood	1,625
Lath	82½		
Lime and cement	131	Total	20,692½

Total approximate value. \$691,400.

LL 15.

HARBOR OF REFUGE AT MILWAUKEE BAY, WISCONSIN.

Object.—To provide a secure anchorage for vessels engaged in the general commerce of the lakes, by inclosing the northern section of Milwaukee Bay within a breakwater, formed of timber cribwork, placed and sunk upon a foundation of stone.

Project.—The project was adopted in 1881, and provided for the construction of a breakwater, the north arm of which commences at a distance of about 600 feet from the north shore of the bay, in a depth of 8 feet of water.

Its direction is S. 25° 19' E., and its length 2,450 feet. From this point the direction of the main arm of the breakwater is changed to S. 11° W. for the proposed distance of 5,200 feet, with an opening of 400 feet at the distance of 1,000 feet from the angle, to provide a fair-weather entrance and exit for vessels.

Present works.—The north arm of the breakwater is completed. The most northerly section of it, 600 feet in length, is comprised of 6 cribs, each 100 feet long and 20 feet wide, and the remaining 1,850 feet of 37 cribs, each 50 feet long by 24 feet wide.

The dimensions of the cribs forming the main arm to the northward of the opening are 50 feet by 24 feet by 22½ feet. Nine hundred feet of this arm to the northward of the opening has been constructed, upon which 875 feet of superstructure has been built to a height of 6 feet above datum, and 4 cribs (Nos. 63, 64, 65, and 66), each 100 feet by 24 feet by 22½ feet, have been sunk to the southward of the opening.

Depth of water.—The slope of the lake bed from the northern end of the breakwater to the angle formed by the north and main arms is 0.87 foot to 100 feet, the angle crib being set in 29.4 feet of water. The average depth of water on the line of section of main arm to the southward of the opening is 34.6 feet.

Operations during the fiscal year.—Under a special agreement made with Christopher H. Starke, dated July 17, 1890, repairs were made to Cribs Nos. 49 and 50 of the breakwater, which were seriously damaged by collision of the steamer *City of Traverse*. The superstructure and

crib timbers were removed to a depth of 2 feet below datum, the length of the lower splintered timbers removed being 28 feet and of the upper timbers 73 feet. The seventh and eighth courses from the top of superstructure were framed together to fit the gap, floated into position, and bolted to the sound timbers of the substructure with bolts 64 inches in length; the remaining six courses being constructed in the usual manner. Forty white-oak piles of dimensions 8 by 12 inches by 30 feet were closely driven and secured to the structure with screw bolts, 24 of which were placed on the seaward side and 16 on the west side of breakwater. Fifty-eight and two-thirds additional cords of stone ballast were used in refilling the cribs and as riprap. The cost of repairing the damage due to this collision, exclusive of superintendence, was \$2,457.55, being somewhat less than the estimate made before the work was done. The damage sustained through the action of storms upon the breakwater during the winter of 1889 and 1890 was repaired at a cost of \$1,789.71.

Under the river and harbor act of September 19, 1890, the sum of \$80,000 was appropriated for improving harbor of refuge at Milwaukee Bay, Wisconsin, and in response to advertisement-inviting proposals, bids were received and opened November 25, 1890, for extending the breakwater 400 feet, more or less, and building superstructure over 400 feet of cribwork already sunk in place. The work was awarded to Christopher H. Starke, who was the lowest bidder, and a contract was entered into by him for doing this work on the 13th day of December, 1890.

During the past winter a large quantity of stone was quarried and secured by the contractor in readiness for the work.

The construction of Crib No. 62 was commenced on May 26, 1891, and it has been built to the required height of 22½ feet.

Two hundred and sixty-six cords of stone have been placed in position for its foundation. This crib is the last to be sunk to the northward of the opening for fair-weather exit. Crib No. 66 is built to a height of 8½ feet.

The scow *Dunham* has been reëngaged to serve as a light-ship at the south end of the breakwater, under a new agreement made with her owner, in accordance with the terms of advertisement and specifications.

Remarks and recommendations.—Several severe storms have occurred during the past year, noticeably that of January 1, 1891, when the southernmost of the cribs, sunk to the southward of the opening for fair-weather exit (No. 66, of dimensions 100 by 24 by 22½ feet), was overturned by a heavy sea from the northeast. An inspection of it shortly after the occurrence showed that it had been carried bodily to the westward of the line of west face of the breakwater. As there was very little or no ice in the lake in the vicinity of the breakwater, it is evident that the crib must have been moved out of its position solely by wave force. The outward or seaward side of Crib No. 65 was also raised about 6 inches during the same storm. A large number of 3-inch planks used for decking the breakwater were broken and a few of the crib timbers carried away.

It is proposed to use hereafter deck planks having a cross-section of 8 by 4 inches.

With a view to the recovery of the crib a subsequent inspection of it was made by a submarine diver, hired for the purpose, and his verbal report of its condition was quite favorable towards making an effort to recover and replace it in position in the breakwater.

The following correspondence gives the particulars of the accident and recommendations as to proposed changes in the size of the cribs:

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., January 24, 1891.

GENERAL: I have the honor to submit the following report of the recent damage to the breakwater of the Milwaukee Harbor of Refuge during the storm of January 1, 1891.

During the months of June, July, and August, 1889, four cribs were sunk to the southward of the opening for fair-weather exit. These cribs were each 100 by 24 by 22½ feet, and were sunk in excellent alignment upon a carefully prepared foundation. The natural depth of water ranged from 32.9 feet to 34 feet, and the preparation of the foundation left about 20 feet of water over the stone. The storm of January 1, 1891, was of great severity, as the following quotation from the daily journal of the observer in charge of the signal station here will show:

"Thursday, January 1, 1891: Light rain continued during day until 3:30 p. m., local time, when it changed to sleet, continuing as such until 5:45 p. m., when it changed to snow, which continued until after midnight.

"The worst storm of the season prevailed to-day; the wind was from the north and northeast, and blew with storm velocity from about 10 a. m., reaching a maximum velocity of 48 miles per hour at 7:10 p. m., accompanied by blinding snow. The storm reached its height at 7:07 p. m., when 1 mile of wind was registered blowing at the rate of 90 miles per hour. Amount of precipitation (rain, sleet, and snow) in past 24 hours, 1.23 inches."

The last crib of the four, the southermost one, was reported soon after the storm as having disappeared, and several attempts were made to examine the condition of affairs, but the water was either too roily or the ice prevented a close approach until the 19th instant, when with a steam tug a good examination could be made. The accompanying tracing shows the approximate condition of the overturned crib. The soundings taken across the foundation would seem to show that some of the stone filling must have fallen through the bottom grillage while the sea was racking and working the crib. The cost of this crib with its filling was \$5,967.48; this of course does not include the foundation. It is my intention to have this crib carefully examined by a diver next season to see if it can not be raised and used again, for a reasonable sum, and in case it can not it ought be broken up and removed, as in its present position it is a somewhat dangerous obstruction to the use of the harbor of refuge.

It may be remembered that on March 23, 1887, three cribs were overturned by the pressure of an ice-floe during an easterly gale. These cribs were but 50 feet long and 24 by 22½ feet in cross-section. This accident led to a modification of the plan by raising the inside berm 4 feet and increasing the length of the crib from 50 to 100 feet.

The Board of Engineers of April 21, 1881 (see page 2122 of Report of Chief of Engineers of 1881), concurred in Major Houston's proposal "to give the cribs at the shore end of the north arm of the breakwater a width of 20 feet, and to increase this width to 30 feet at its outer end, unless experience should show that this width of 30 feet can be safely reduced." * * * "Should experience show that a less width than 30 feet will give sufficient strength to the outer end of the north arm, this less width can also be used for the main arm of the breakwater."

It would seem as though experience was demonstrating that an increase of width in the cribs was called for, and although the contract is already let for an extension of 400 feet, more or less, of the breakwater, with cribs of 24 feet width, a careful study of the subject will be made and estimates prepared for increasing the width to 30 feet.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 5, 1891.

MAJOR: I have to acknowledge the receipt of your report of the 24th ultimo, regarding the damage to the breakwater of the Milwaukee harbor of refuge during the storm of January 1, 1891, and to advise you that your proposition to submit an

estimate for increasing the width of the cribs for this break water to 30 feet is approved by the division engineer and by this office.

By command of Brigadier-General Casey:

Very respectfully, your obedient servant,

H. M. ADAMS,
Major, Corps of Engineers.

Maj. CHAS. E. L. B. DAVIS,
Corps of Engineers.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE.

Detroit, Mich., February 7, 1891.

Respectfully transmitted.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

UNITED STATES ENGINEER OFFICE.

Milwaukee, Wis., February 11, 1891.

GENERAL: In accordance with instructions contained in Department letter of February 5, 1891, I have the honor to submit the following report upon the question of the necessity of enlarging the width of the cribs used in the construction of the breakwater of the harbor of refuge at Milwaukee, Wis.

On the accompanying sketch Fig. 1 shows a cross section of the last 24-foot crib and the foundation of riprap stone. It will be seen that it was sunk in 34.6 feet of water, on a foundation of stone 14.6 feet in depth, with an exterior slope of 1 on 2, and interior one of 2 on 3, the top width of the foundation being 40 feet, thus allowing a berm of 8 feet on each side of the crib.

The crib itself is 100 feet long, 24 feet wide, and 22½ feet high. At the present low stage of water the top of the crib projects about 2½ feet above the water surface.

A crib of this size contains the following materials:

Pine timber.....	feet, B. M.	140,340
Wrought-iron bolts.....	pounds..	14,446
Limestone.....	cords..	303

As is to be expected, the weight of a cubic foot of pine timber is variously given by the standard authorities, depending upon the quality of the timber and its degree of dryness, while nothing is given as to its weight after being water-soaked. General Cram, in a memoir published in the Report of the Chief of Engineers for 1868, gives, as the result of his own experiment, the weight of water-soaked white-pine timber at 39½ pounds per cubic foot. I therefore assume 40 pounds as the approximate weight and 486.75 pounds per cubic foot as the weight of wrought-iron bars given in Professional Papers No. 12. The actual weight of the stone used in the cribs, as determined by careful experiments, is 163 pounds. With these figures, and allowing one-third for voids in the stone, there would be 25,856 cubic feet of stone, 11,695 of timber, and 30 of iron; or a total of 37,581 cubic feet.

This would make the total weight of the submerged crib as follows:

$$\frac{25,856 \times 163 + 11,695 \times 40 + 14,446 - 37,581 \times 62.5}{2,000} = 1,173.981 \text{ tons,}$$

or 0.489 of a ton per square foot; that is about half a ton.

This is a weight per running foot of 11.74 tons, which, with a lever arm of 12 feet, gives 140.88 foot tons to resist overturning.

At the present low level of the lake the top of the crib is ordinarily about 2½ feet above the water surface, but during northeasterly gales the water banks up on this shore so that the cribs are entirely submerged except during the brief intervals of exposure in the trough of a wave, so that the crib may be regarded as entirely submerged in the computations for weight.

According to Stevenson's formula all the lakes have lengths of exposure great enough to generate waves over 20 feet in height, but no such waves have ever been observed. The Board of Engineers of 1845 were of the opinion that waves under the heaviest winds do not exceed 10 feet in height from the trough to the summit in Buffalo Harbor. Observations at Eagle Harbor, Lake Superior, in 1876, gave the height of the maximum waves at 10 to 12 feet. Colonel Robert's observations with dynamometers at Oswego Harbor (see Report of Chief of Engineers, 1885, Part III, p.

Lake
~~XXXXXXXXXXXX~~

Lake
~~XXXXXXXXXXXX~~

Photo-Lith. by A. HENZ & CO., St.

2279), showed that waves attained a height of 14 to 18 feet, and the breakwater at times is subjected to a force of over 1,000 pounds per square foot.

The opinion of people conversant with Lake Michigan is to the effect that waves rarely exceed 10 feet in height, so perhaps 12 feet may be taken as a maximum. General Cram, in the memoir before referred to, says: "The force of these waves is not percussive, like that of a trip hammer; it is much more like pressures increasing and then decreasing as the wave comes up and recedes; and I treat the subject by taking the point of application of the resultant of these pressures during the storm to be $\frac{2}{3}$ feet below the upper limit of the surface pressed." This is the law of hydrostatic pressure. The more recent observations do not confirm this view. Dehauve says: "We can not take the height of the wave as a measure of the pressure, for it is not a question of hydrostatic pressure, and the liquid molecules have accelerations that may be added to or subtracted from that of gravity. Observations taken at the port of Havre in fact demonstrated that the law of hydrostatic pressure did not hold." (See page 509, *Des Eaux comme Moyen de Transport*.)

Regarding the wave as reaching the breakwater and rolling up the outer slope, thus becoming a wave of translation and exerting its full force throughout the entire height of 22.5 feet, we should have

$$\frac{140.88}{22.5 \times 11.25} = 0.55 \text{ of a ton};$$

that is, a wave pressure much exceeding half a ton would be sufficient to overturn the crib. Now the line of direction of the crib is 11 degrees west of south, so a northeast line—the line of direction of the worst storms—would make an angle of 34 degrees with the outer face of the crib, and with a normal component of pressure of 0.55 of a ton would require the pressure in the line of wave propagation to be very nearly one ton, viz, 0.983 of a ton. This is considerably greater than any recorded observations on the lakes. But however defective the wave theory may be, the fact remains that the crib was overthrown, though it is probable that this was done gradually by rocking the crib and letting some of the stone out through the bottom grillage, and not by some one wave of very unusual intensity.

The Board of Engineers of April 21, 1881, says: "Major Houston proposes to give the cribs at the shore end of the north arm of the breakwater a width of 20 feet, and to increase this width to 30 feet at its outer end, unless experience should show that this width of 30 feet can be safely reduced. The Board concurs in this. Should experience show that a less width than 30 feet will give sufficient strength to the outer end of the north arm, this less width can also be used for the main arm of the breakwater."

Experience seemed to warrant a less width than 30 feet, and therefore a width of 24 feet has hitherto been considered sufficient.

Fig. 2 of the accompanying sketch shows in cross section a crib 100 feet long, 30 feet wide, and 22.5 feet high. The following are the estimated quantities of materials and cost of same:

157,764 feet B. M. of pine timber (framed), at \$27.....	\$4,259.63
319 pounds of iron screw bolts, at 4 cents.....	12.76
14,852 pounds of iron drift bolts ($1\frac{1}{4}$ inches round), at 3 cents.....	445.56
388,512 cords of stone ballast, at \$7.....	2,719.58
7,000 feet B. M., of 4 inches by 8 inches white pine plank, at 14 cents.....	98.00
600 pounds of iron spikes (wrought, 10 inches by $\frac{1}{4}$ inch), at 4 cents.....	24.00
Laying 7,000 feet plank, at \$5.....	35.00
600 feet B. M. pine boards, 1 inch, at \$20.....	12.00
Taking up 7,000 feet plank, at \$5.....	35.00
Cost of one crib.....	7,641.53

Cost of foundation.

816 cords of stone, at \$7.....	\$5,712.00
33 cords of large covering stone to outer slope and berme, at \$12.....	396.00
	6,108.00
Cost of superstructure.....	1,672.96

SUMMARY.

Cost of crib.....	\$7,641.53
Cost of foundation.....	6,108.00
Cost of superstructure.....	1,672.96
Total cost of 100 feet breakwater.....	15,422.49
Add 10 per cent. for contingencies.....	1,542.24
	16,964.73
Cost per running foot of breakwater.....	169.64

Making the same computations as before, this crib would exert a pressure upon its foundation of 1,517.7 tons, or 0.506 of a ton per square foot, and would give a moment of resistance to overturning of 227.65-foot tons per running foot, being an increase of nearly 62 per cent. over that of a 24-foot crib.

The cost per running foot of breakwater, including foundation, substructure, and superstructure, would be as follows:

For 24-foot crib, \$144.20; for 30-foot crib, \$169.64, or an increase of 18 per cent.

The length of the south arm of the breakwater is 3,800 feet. Four hundred feet of this were laid in the season of 1889, the outer crib of which has just been overturned. The contract already let calls for 400 feet more, which will leave 3,100 feet yet to be built. To build this of 30-foot cribs will increase the cost from \$447,020 to \$525,354, an increase of \$78,834.

The actual cost of the overturned crib with its filling was \$5,967.48. It will therefore be seen that from an economical point of view the occasional loss of a crib during a storm of exceptional severity would be much cheaper than resorting to the more expensive mode of construction.

Fig. 3 of the appended sketch shows a cross-section of a crib built with a projection at the base in order to increase the length of the lever arm. There is a model of such a crib in this office, but there is no report relating to it on file. There would be some mechanical difficulties of construction and of handling, and it is doubtful, taking into consideration the increase of stone foundation, if it would be cheaper in the end than a wider crib with straight sides.

The following are the widths of the cribs at the various lake harbor breakwaters:

	Feet.
Buffalo, N. Y.	38
Oswego, N. Y.	35
Michigan City, Ind.	30
Marquette, Mich. (old)	30
Milwaukee, Wis.	24
Sand Beach, Mich.	38
Cleveland, Ohio.	32
Chicago, Ill.	30
Marquette, Mich. (new)	24

It will be seen that with one exception Milwaukee has the narrowest section, but it is to be borne in mind that Milwaukee Bay is partially sheltered and its breakwater is not subjected to such heavy seas as frequently prevail at Oswego, Sand Beach, and Marquette.

The signal observer here stated in a published article in the daily papers that the extreme velocity of the wind on January 1 was 90 miles an hour, "the highest January wind velocity during the past 20 years," so there can be no doubt that the storm was one of very exceptional severity.

On looking over the record I find that the damage done to the Milwaukee breakwater by storms has been as follows:

Three cribs, 50 feet long, overturned by sea and ice March 23, 1887.....	\$9,200.71
One crib overturned January 1, 1891, 100 feet long.....	5,967.48
Total	15,168.19

This out of a total expenditure up to date of \$402,313.37.

An examination of the reports of the damages by storms to the various lake breakwaters disclosed that Milwaukee has suffered very little in comparison with other harbors and that the above-named amount of damage was exceptionally small.

In conclusion, therefore, I would recommend that no change in size of crib be made at present, that the contract with C. H. Starke of December 13, 1890, for building 400 linear feet of cribs 24 feet wide be adhered to, and that further experience be waited for before any change of plan is decided upon.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

DETROIT, MICH., February 20, 1891.

Respectfully forwarded. The recommendation of Major Davis, as expressed in the closing paragraph of this report, is concurred in by me.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
February 24, 1891.

Respectfully returned approved as recommended by the Division Engineer.

By command of Brigadier-General Casey:

H. M. ADAMS,
Major, Corps of Engineers.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

Money statement.

July 1, 1890, balance unexpended.....	\$9,298.85
Amount appropriated by act approved September 19, 1890.....	80,000.00
	<hr/>
June 30, 1891, amount expended during fiscal year	9,298.85
	9,220.09
July 1, 1891, balance unexpended.....	80,078.76
July 1, 1891, amount covered by uncompleted contracts.....	70,000.00
	<hr/>
July 1, 1891, balance available	10,078.76
	<hr/>
{ Amount (estimated) required for completion of existing project	309,737.91
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	200,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for building 400 linear feet of breakwater extension and superstructure, harbor of refuge at Milwaukee Bay, Wisconsin, received in response to advertisement dated October 27, 1890, and opened November 25, 1890, by Maj. Charles E. L. B. Davis, Corps of Engineers.

Amount of appropriation available for this work, \$70,000.

No.	Name and address of bidder.	Pine timber, 671,360 feet, B. M. (per M).	Pine plank, 41,000 feet, B. M. (per M).	Pine boards, 2,100 feet, B. M. (per M).	Drift bolts, 71,250 pounds (per pound).	Screw bolts, 1,378 pounds (per pound).	Spikes, 4,916 pounds (per pound).	Stone, 4,792 cords (per cord).	Framing pine timber, 671,360 feet, B. M. (per M).	Laying pine plank, 41,000 feet, B. M. (per M).	Taking up plank, 25,000 feet, B. M. (per M).	Total for 400 feet.
1	Hiero B. Herr & Co., Chicago, Ill.	\$20	\$16	\$20	Cts. 4	Cts. 5	Cts. 5	\$8.00	\$7.50	\$6	\$4	\$60,687.10
2	Charles Berner, Green Bay, Wis.	18	15	18	3½	4	4	7.50	7.50	5	5	56,487.99
3	Christopher H. Starke, Milwaukee, Wis.	16	14	20	3	4	4	7.00	8.00	5	5	52,711.90
4	Knapp & Gillen, Racine, Wis.	18	15	15	3½	4	4	7.25	7.25	5	5	55,125.85

With the approval of the Chief of Engineers, a contract was entered into December 13, 1890, with Christopher H. Starke, the lowest responsible bidder, for this work.

SHIPMENTS.

	Tons.		Tons.
Barley	118,269½	Mill stuffs	70,598
Butter	297½	Oats	30,566
Coal	522,618	Pig iron	56,964
Corn	5,488	Pork, ham, beef, shoulders, and mid-	
Flour	344,173½	dles	28,917
Hides	620½	Potatoes	8,170
Hogs	5,119	Salt	70,171
Lard	5,817	Wheat	58,563½
Lumber	291,963		
Malt	47,947½	Total	1,679,516
Meats (bulk)	18,252		

MANUFACTURES.

Articles.	Value.	Quantity.
		Tons.
Beer	\$11,100,000	337,414
Boots and shoes	8,000,000	
Cement		63,250
Cigars	1,200,000	
Tobacco	1,850,000	
Flour		150,181
Pig iron		113,500
Tinware	1,200,000	
Sash, doors, and blinds	7,000,000	
Engines and general machinery	5,500,000	
Product of rolling mills	5,500,000	

MISCELLANEOUS.

Bank deposits	\$847,517,053.54
Receipts of office of internal revenue	3,192,120.42

L L 17.

IMPROVEMENT OF RACINE HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into Root River, at the mouth of which the city and harbor of Racine are situated.

Project.—The original project for the improvement of this harbor was made and adopted in 1842 or 1843. Its intention was to provide and maintain a channel 12 feet deep by dredging between protection piers, constructed of crib work placed parallel to each other and 160 feet apart, the distance from the shore line to 12 feet of water in Lake Michigan being about 800 feet.

In 1866 the project was modified with a view to providing a channel of 15 feet in depth.

Under this modification the north pier has been extended 630 feet and the south pier about 500 feet.

Present works.—The north pier is about 1,460 feet in length. Its western section of 200 feet in length is 12 feet in width; its middle section of 960 feet in length is 20 feet wide, and its outer or eastern section of 300 feet in length is 30 feet wide. The south pier is 1,070 feet in length; its inner or western section of 530 feet in length is 16 feet in width, and its outer or eastern section of 540 feet in length is 20 feet in width. The north or weather pier extends 380 feet farther into the lake than the south pier.

Depth of water.—The natural depth of water on the bar in front of the mouth of the river before artificial improvement was made was variable. The effect of a northeast storm would be to deposit sand to such an extent as to completely obstruct the entrance until an accumulated head of water in the river became sufficient to remove the barrier, and upon a change of wind sometimes a narrow channel of 5 or 6 feet would be scoured out.

The work done under the project previous to 1860 provided a channel of from 9 to 10 feet in depth. The extension of the piers, with the periodical dredging which has been done since 1866, has generally maintained a channel of from 13 to 15 feet in depth, but the maintenance of a 15-foot channel is dependent upon a frequent use of the dredge.

A plat of soundings taken between the harbor piers on the 11th of April of this year, on which is also included soundings taken on the 19th of May over an extensive area outside of the piers and to the depth of 20 feet of water in Lake Michigan, shows that extensive deposits of sand have been made since dredging was done in May, 1890, which debar vessels drawing 13 feet of water from entering the harbor during stormy weather.

To the northward of the harbor piers the 12-foot contour line overhangs the eastern extremity of the north pier, and the bar from the southward projects into the channel, with but 12 feet of water on its crest. The banks alongside the piers have increased to such an extent, that the contour lines of 12 feet are not more than 45 feet apart in the narrowest part of the channel, near its west end.

Operations during the fiscal year.—Under the river and harbor act of September 19, 1890, the sum of \$17,500 was appropriated by Congress for continuing the improvement of Racine Harbor.

In response to public advertisements, proposals were received and opened on November 25, 1890, for extending the south pier into Lake Michigan to a farther distance of 200 feet by constructing four cribs, each of dimensions 50 feet by 20 feet by 18½ feet, and sinking them on a foundation of piles, driven and cut off on alignment to receive them. Offers to do this work were made by five contractors, the lowest bid received being that of Messrs. Truman and Cooper, of Manitowoc, Wis., and a contract was formally entered into with them on the 13th day of December, 1890, under which they are to complete the specified work on or before the 15th day of October, 1891.

In view of the difficulty of entering the harbor, and the necessity for immediate relief by dredging, a circular letter was sent to contractors, dated May 27, 1891, requesting bids for deepening the channel between the piers and on the bar at harbor entrance, as far as the available funds would admit, by dredging to a depth of 15 feet and to a width of 80 feet, the quantity of material to be removed being about 14,000 cubic yards.

The bid of Mr. S. O. Dixon, 19½ cents per cubic yard, was the lowest offer, and an agreement was entered into with him for doing the necessary work on the 15th day of June, 1891.

Work was commenced by the dredge under this agreement on the 22d day of June, 1891, since which time 4,089 cubic yards of material have been removed from the center of the channel between the piers.

Remarks and recommendations.—Until both piers are extended farther into the lake a frequent use of the dredge will be necessary. The superstructure of the western section of the north pier, 200 feet in length by 12 feet in width, and 635 feet of its middle section of 20 feet in width, is becoming dilapidated.

Three hundred and ten feet in length of the superstructure at the west end of the south pier needs to be renewed.

The north pier should be extended 300 feet and the south pier 500 feet, or 300 feet beyond the eastern extremity of the work to be done under the present contract of Messrs. Truman and Cooper.

Money statement.

July 1, 1890, balance unexpended.....	\$543.59
Amount appropriated by act approved September 19, 1890.....	17,500.00
	18,043.59
June 30, 1891, amount expended during fiscal year.....	399.71
	17,643.88
July 1, 1891, balance unexpended	17,643.88
July 1, 1891, amount covered by uncompleted contracts.....	14,000.00
	3,643.88
July 1, 1891, balance available	3,643.88
{ Amount (estimated) required for completion of existing project.....	64,500.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	50,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for building 200 linear feet of pier extension at Racine Harbor, Wisconsin, received in response to advertisement dated October 27, 1890, and opened November 25, 1890, by Maj. Charles E. L. Davis, Corps of Engineers.

Amount of appropriation available for this work, \$14,000.

Number.	Name and address of bidder.	Pine timber, 112,800 feet, B. M. (per M).	Hemlock timber, 120,000 feet, B. M. (per M).	Pine plank, 12,000 feet, B. M. (per M).	Stone, 650 cords (per cord).	Foundation piles, No. 102 (each).	White oak piles, No. 20 (each).	White pine timber, 10,000 ft., B. M. (per M).	Drift bolts, 16,700 pounds (per pound).	Screw bolts, 5,200 pounds (per pound).	Spikes, 560 pounds (per pound).	Total for 200 feet.
1	Hiero B. Herr & Co., Chicago, Ill.	\$28	\$23	\$24	\$0.50	\$13.00	\$14	\$35	Cts. 4	Cts. 5	Cts. 5	\$15,293.40
2	Horatio Truman and George Cooper, Manitowoc, Wis.	26	22	18	7.50	12.00	12	30	3	4	4	13,219.20
3	Christopher H. Starke, Milwaukee, Wis.	27	25	24	10.00	15.00	12	40	4	6	5	16,011.60
4	Peter W. Galloway, Racine, Wis.	33	29	24	10.50	50.00	12	33	4	5	5	20,941.40
5	Knapp & Gillen, Racine, Wis.	27	22	20	8.50	10.40	10	30	4	5	5	13,967.40

With the approval of the Chief of Engineers, a contract was entered into December 13, 1890, with Horatio Truman and George Cooper, the lowest responsible bidders for this work.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1890.

[Furnished by the common council of the city of Racine.]

Name of harbor, Racine, Wis.; collection district, Milwaukee, Wis.; nearest port of entry, Milwaukee, Wis.; amount of revenue collected at the nearest port of entry, \$328,360.08.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	Tons.	No.	Tons.
Steam	584	408, 830	639	426, 300
Sail	422	89, 802	461	98, 450
Total	1, 006	498, 632	1, 100	524, 750

Principal articles of export and import.

EXPORTS.

	Tons.		Tons.
Agricultural implements	32, 592½	Peas	
Beer	3, 790½	Pork and beef	48½
Brick	22, 396	Posts (fence)	1, 019
Butter	17½	Sash, doors, and blinds	117
Chairs	192½	Shingles	163½
Fish	112½	Stone	3, 500
Furniture	271½	Wagons and carriages	10, 536
Hay	12, 840	Wood	1, 875
Lath	412½	Wool	95½
Leather	498½	Total	244, 574½
Merchandise, (general)	139, 750	Total approximate value	\$8, 889, 117. 70
Mill stuffs	11, 653		
Oats	444½		
Oil	2, 247		

IMPORTS.

	Tons.		Tons.
Apples	183½	Oats	1, 083
Bark (tan)	1, 793	Oil	1, 977
Barley	2, 357½	Paper	283
Beer	5, 687½	Posts (fence)	1, 402½
Brick	600	Potatoes	199½
Cattle	258	Provisions	354
Coal and coke	99, 065	Salt	1, 588½
Corn	632½	Sash, doors, and blinds	39½
Flour	516	Sheepskins	126½
Gambier	324½	Shingles	600
Hay	5, 025	Tobacco	43½
Hides	569½	Wheat	5, 628
Iron and steel	22, 711	Wood	36, 475
Lath	687½	Wool	87½
Leather	279½	Total	1, 603, 736½
Lime and cement	1, 830½	Total approximate value	\$3, 625, 580
Lumber	60, 000		
Merchandise (general)	1, 351, 328		

L L 18.

IMPROVEMENT OF KENOSHA HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into the extensive basin at the mouth of Pike Creek, upon which the city and harbor of Kenosha are situated.

Project.—The original project for the improvement of this harbor, adopted in 1852, was to secure a channel 12 feet deep from 12 feet of water in Lake Michigan to the interior basin or bayou by the construction of piers placed parallel to each other and 150 feet apart and by dredging between them. In 1866 a modification of the original project was made in order to provide a navigable channel 15 feet in depth.

Present works.—The north pier is 1,600 feet in length. Its inner or western section, which was built either by private parties or the city of

Kenosha, is of pile work, 365 feet in length and 12 feet in width. The adjoining section to the eastward, built under the original project of 1852, is of crib work, 610 feet long, and 18 feet wide. The extension of this pier since 1866 is 625 feet long, 250 feet of which is 30 feet wide.

The south pier is 800 feet long and 20 feet wide, commencing at the shore line and extending into the lake.

The north pier extends 420 feet farther into the lake than the south pier.

Depth of water.—The natural depth of water at the mouth of Pike Creek before it was improved changed with each recurring easterly storm; not more than 2 or 3 feet could be depended upon at the entrance. The work first done under the project furnished a channel of from 9 to 10 feet in depth between the piers.

The extensions of the piers since 1866, together with periodical dredging, have generally provided a channel about 12 feet in depth, but in order to maintain a greater depth of water frequent applications of the dredge have been necessary.

Soundings were taken in the harbor basin, previous to the commencement of dredging operations, and early in May, 1891, minute soundings were taken between the harbor piers, and also over a large area outside of the piers, to the line of 20 feet of water in Lake Michigan. A plat of these soundings showed that it was practicable for a vessel drawing not more than 13 feet of water to enter the harbor, but as the channel was tortuous, the removal of about 6,000 cubic yards from projecting banks and the crest of the bar at entrance was found to be necessary to effect a safe entrance with a draft of 13 feet.

Operations during the fiscal year.—Under the river and harbor act of September 19, 1890, appropriating \$17,500 for the improvement of Kenosha Harbor, a condition was made that \$2,500 of this sum should be expended in dredging in the harbor basin, in conformity with which an agreement was made with Mr. S. O. Dixon for excavating a channel of 80 feet in width across the basin from the west end of the harbor piers to the wharves on the west side of basin, and for excavating and removing the material to a depth of 14 feet over an area sufficiently large to admit of the maneuvering and winding of vessels, discharging or taking on freight from the wharves in the basin. The area over which dredging has been done is nearly 3 acres in extent. The character of the material forming the bed of the basin is chiefly mud. The quantity of material removed under this agreement was 20,918.8 cubic yards, at a cost of 11½ cents per cubic yard.

On May 19, 1891, a circular letter was sent to the owners of dredging plants requesting bids for removing about 6,000 cubic yards of material from banks between the harbor piers and from the bar at entrance, in answer to which three proposals were received. The lowest offer made to do this work was 19 cents per cubic yard, that being the bid of Mr. F. M. Knapp, and on the 3d of June, 1891, an agreement was made with him to remove the obstructions to the depth of 14 feet on those terms. This work was completed on June 19, 1891, the quantity of material removed being 5,402.5 cubic yards.

Under the provisions of act of September 19, 1890, the larger share of the appropriation is being applied to the extension of the south pier. In answer to advertisement of October 27, 1890, proposals were received and opened on November 25, 1890, for extending this pier 150 feet, by constructing three cribs, each of dimensions 50 by 20 by 18½ and sinking them on a foundation of piles driven and cut off on alignment for their reception. Five bids to do this work were received, the

lowest being from Messrs. Truman and Cooper, of Manitowoc, Wis., and a contract was entered into with them for doing the work, on the 13th day of December, 1890. The three cribs under this contract have been constructed and sunk in accordance with specifications, but the full complement of stone ballast is not yet delivered, nor the requisite superstructure built.

Remarks and recommendations.—A plat of the soundings taken last month shows that the contour line of 12 feet of water overlaps the east end of the north pier at a distance of 200 feet to the northward of the piers, and the bar, which constantly forms to the southward, protrudes into the channel from that direction. These growing obstructions show that a channel of 12 feet in depth can not be maintained without constant dredging until the piers are extended farther into Lake Michigan.

Money statement.

July 1, 1890, balance unexpended	\$1,435.23
Amount appropriated by act approved September 19, 1890	17,500.00
	18,935.23
June 30, 1891, amount expended during fiscal year	2,886.20
July 1, 1891, balance unexpended	16,049.03
July 1, 1891, outstanding liabilities	\$1,151.47
July 1, 1891, amount covered by uncompleted contracts	10,000.00
	11,151.47
July 1, 1891, balance available	4,897.56
{ Amount (estimated) required for completion of existing project	64,500.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	50,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for building 150 linear feet of pier extension at Kenosha Harbor, Wisconsin, received in response to advertisement dated October 27, 1890, and opened November 25, 1890, by Maj. Chas. E. L. B. Davis, Corps of Engineers.

Amount of appropriation available for this work, \$10,500.

No.	Name and address of bidder.	Pine timber, 85,000 feet B. M. (per M.).	Hemlock timber, 40,000 feet B. M. (per M.).	Pine, plank, 9,000 feet B. M. (per M.).	Stone 500 cords (per cord).	Piles, No. 78 (each).	Drift bolts, 11,625 pounds (per lb.).	Screw bolts, 3,300 pounds (per lb.).	Spikes, 420 pounds (per lb.).	Total for 150 feet.
1.	Hiero B. Herr & Co., Chicago, Ill	\$30	\$23	\$24	\$10.00	\$13	Ots. 4	Ots. 5	Ots. 5	\$11,519.00
2.	Horatio Truman and George Cooper, Manitowoc, Wis	28	23	18	7.50	12	3	4	4	9,812.35
3.	Christopher H. Starke, Milwaukee, Wis	30	25	24	10.00	15	4	6	5	11,888.00
4.	Peter W. Galloway, Racine, Wis	33	29	24	13.50	50	4	5	5	16,951.80
5.	Knapp & Gillen, Racine, Wis	30	25	20	10.00	12	4	5	5	11,585.00

With the approval of the Chief of Engineers, a contract was entered into December 13, 1890, with Horatio Truman and George Cooper, the lowest responsible bidder, for this work.

2568 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1890.

[Furnished by the Hon. O. M. Pettit, Mayor of Kenosha.]

Name of harbor, Kenosha, Wisconsin. Collection district, Milwaukee, Wis. Nearest port of entry, Milwaukee, Wis. Amount of revenue collected at the nearest port of entry, \$328,360.08.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	No.	Tons.	No.	Tons.
Steam.....	58	9,961	58	9,954
Sail.....	161	20,984	156	20,600
Total.....	219	30,945	217	30,554

Principal articles of export and import.

EXPORTS.

	Tons.
Horses.....	4
Merchandise (general).....	11
Oats.....	4½
Sand.....	4,050
Total.....	4,069½

IMPORTS.

Apples.....	3½
Bark (tan).....	13,200
Coal and coke.....	10,900
Lath.....	275
Lumber.....	18,750
Posts (fence).....	314½
Potatoes.....	105
Shingles.....	450
Slabs.....	1,680
Stone.....	425
Wood.....	4,250
Total.....	50,352½
Total approximate value.....	\$195,530

L L 19.

IMPROVEMENT OF WAUKEGAN HARBOR, ILLINOIS.

Object.—To provide a shelter for the protection of vessels engaged in the commerce of the city of Waukegan.

Project.—In 1852 an appropriation of \$15,000 was made for the “improvement of the harbor and breakwater at Waukegan, Ill.” The plan adopted was a breakwater parallel to the shore in 20 feet of water. One crib, 30 feet by 25 feet, was placed in position, but was carried away by a storm and the work then abandoned. In 1872 an examination and report were made, as called for by the river and harbor act of that year. This plan contemplated a breakwater in 24 feet of water. No action was taken on this report.

The character of the improvement of this harbor is somewhat different from that of other points on the great lakes. Most of the improvements have consisted in deepening the mouths of streams emptying into the lake, but at Waukegan there is only a creek emptying into the lake, and it is of no importance for harbor purposes.

The present project was adopted in 1880, its intention being to construct an exterior basin of sufficient capacity to meet the requirements of the local trade by inclosing a portion of Lake Michigan within piers constructed of pile work, and an entrance channel between piers from a depth of 12 feet of water in Lake Michigan to the basin; the channel and basin to be excavated by dredging to the depth of 12 feet.

Present works.—The length of the north pier is 1,259.6 feet; the length of the south pier is 1,024.9 feet, making a total length of pier work of 2,284.5 feet.

The north pier, which incloses the basin, is comprised of three sections, the first of which runs easterly from inside the shore line as it existed in 1879 for a distance of 345 feet into the lake. This section is comprised of a single row of 12 by 12 inch squared pine piles, reënforced at the angle or outer end for a length of 80 feet with oak piles driven at a distance of 12 feet from the front row, the interior space being filled with stone ballast.

The next section of pile work, 16 feet wide, runs in a southerly direction for a distance of 380.8 feet to the channel angle.

The outer section of 16 feet in width, which runs in an easterly direction for a distance of 533.8 feet from the channel angle into Lake Michigan, is comprised of two rows of closely driven white-oak piles, divided into sections by cross rows driven at distances of about 32 feet apart, double sheeted with 3-inch pine plank, and filled with stone ballast to a height of 2 feet above datum.

The south pier is built upon a prolongation of the line of the south side of Madison street, in the city of Waukegan. The inshore section of this pier, 140.3 feet, is comprised of a single row of square pine piles of dimensions 12 by 12 inches by 18 feet, with the exception of the outer 24 piles, which are 22 feet in length and 12 inches square.

The next outer section of 100 feet in length is constructed of round white oak piles, each 30 feet in length, on alignment at distances of 3 feet from center to center, and sheeted with two rows of planks of dimensions 3 inches by 12 inches by 22 feet, driven close and breaking joints, and spiked to the wales which inclose and secure the round piles.

The next section to the eastward, of 109 feet in length, is built with round white-oak piles, each 30 feet long, driven at distances of 3 feet from center to center and secured with binders. On the south side of this row pine piles of 8 inches by 12 inches by 26 feet are driven in close contact and bolted to the binder and reënforced with a pine binder of 3 by 12 inches.

The outer section of this pier, 675.6 feet in length, is comprised of two parallel rows of white-oak piles of 31 feet in length, driven in close contact at distances of 14 feet from center to center of rows and divided into sections of about 32 feet each. These rows are secured and bound in place by means of wales, binders, screw bolts, and tie-rods in a similar manner to those of the outer section of the north pier.

On the south side of the north row a double sheeting of pine plank 3 inches by 12 inches by 22 feet is driven, and spiked to the wales in a similar manner to the second section. The interior of this section has been filled with stone ballast to a height of 2 feet above datum, but in some places it has settled somewhat below that level.

In the construction of these piers it has been necessary to place a riprap of stone along the outer sides of the piles as fast as they have been driven.

Depth of water.—Before work was commenced upon this harbor the distance from the line of shore, in front of which the piers have been

constructed, to the natural depth of 12 feet of water in Lake Michigan was about 870 feet, but as the work has progressed an extensive accretion has been formed to the northward of the harbor. The shore line now intersects the north pier at a distance of 600 feet outside or to the eastward of the line of shore as it existed in 1879, and the depth of 12 feet of water is about 350 feet outside that former line of depths, or more than 1,200 feet to the eastward of the line of shore of 1879.

At the close of operations with the dredge, on the 24th of October, 1889, a channel was available for navigation between the piers 120 feet wide, 550 feet long, and 12 feet deep, and in the basin the water was 12 feet deep for a length of 600 feet and a width of 160 feet.

At the present time there is but a very narrow channel close to the north pier (about 30 feet in width), which is available for small craft drawing not more than 8 feet of water, an extensive bank of sand with but 3 to 4 feet of water over it having been formed since dredging was done in 1889, and covering two-thirds of the area inclosed between the north and south piers.

Operations during the fiscal year.—Under the provisions of the river and harbor act of September 19, 1890, appropriating \$35,000 for the improvement of Waukegan Harbor, operations have been commenced by hired labor and purchase of materials as follows: In the latter part of October and in November, 1890, the whole of the bed and frame timbers of the pile driver belonging to the United States were taken out, and the decayed timbers were replaced with new material, the whole machinery being put in good working condition in readiness for operations during the present working season. The total cost of making these repairs was \$897.64. Proposals were received in response to circular notices, which were extensively issued, requesting bids to furnish the necessary materials for constructing extensions to the harbor piers. The lowest bids received and accepted in conformity with the conditions specified in the circulars were from the following parties, viz:

J. M. Laurie, of Sturgeon Bay, for stone ballast.....	per cord..	\$7. 00
George Kirk & Son, of Waukegan, for pine plank, 3 inches by 12 inches by 24 feet.....	per M. ft. B. M..	19. 50
Cairo Lumber Company, of Chicago, for 6 inches by 12 inches by 18 feet and 20 feet oak timber	per M. ft. B. M..	24. 50
Chicago Forge and Bolt Company, for iron rods, machine bolts, and spikes per pound.....		. 02 ⁴ / ₁₀
Chicago Forge and Bolt Company, for iron screw bolts.....	per pound..	. 02 ⁴ / ₁₀
F. Bairstow, of Waukegan, for coal for engine of pile driver.....	per ton..	4. 25

Early in April the pile driver was moved around the harbor basin from the west end of the south pier to the outer end of the north pier, and on the 23d of April pile driving was commenced for the extension of this pier on a line parallel with the direction of the south pier. A foot-walk was constructed on the north pier before pile driving was commenced.

The first consignment of 68 cords of stone from Sturgeon Bay reached Waukegan on the 6th of May, 1891. At a distance of from 20 to 32 feet from the eastern extremity of the north pier the sand overlying the clay was scoured out by wave action to a depth of 22 feet during the storms of the past winter. Piles 34 feet long were used to cross over this section. Up to this date six sections of 32 feet each in length have been completed, making an extension of 192 feet to the north pier.

Remarks and recommendations.—At the close of the fiscal year the work is progressing favorably, and it is proposed to extend the north pier to a farther distance of 192 feet, making a total extension of 384 feet during this working season.

The extension of the south pier will then be commenced, the proposed length of which is 256 feet, together making a total length of 640 feet.

The shore accretions have continued to gather to the northward of the harbor piers, and the volume of sand, drifted by wind along the beach, is increasing as the width of the beach is increased by the advance of the shore lakewards. A large deposit of this drift was made in the harbor channel during the past winter.

With a view to arrest the passage of the drift an experimental fence 128 feet long has been built, at a cost of 22.4 cents per running foot. If this fence should prove to be as effective as is anticipated, it is proposed to erect a similar fence to the southward of that which is already built.

Money statement.

July 1, 1890, balance unexpended	\$4,083.62
Amount appropriated by act approved September 19, 1890.	35,000.00
	<hr/> 39,083.62
June 30, 1891, amount expended during fiscal year	13,556.82
	<hr/> 25,526.80
July 1, 1891, balance unexpended	25,526.80
July 1, 1891, outstanding liabilities	2,247.95
	<hr/> 23,278.85
July 1, 1891, balance available	23,278.85
	<hr/>
{ Amount (estimated) required for completion of existing project	86,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	50,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1890.

[Furnished by the honorable H. C. Hutchinson, mayor of Waukegan.]

Name of harbor, Waukegan, Ill.; collection district, Chicago, Ill.; nearest port of entry, Chicago, Ill.; nearest light-house, Waukegan, Ill.; amount of revenue collected at the nearest port of entry, \$5,194,691.86.

Arrivals and departures of vessels.

	Arrivals.	Departures.
Steam*	100	100
Sail*	44	44
Total	144	144

*Tonnage not known.

Principal articles of export and import.

EXPORTS.

	Tons.		Tons.
Beer	2,240	Hogs	168
Butter	160	Lumber	6,750
Cattle	540	Wool	30
Fish	60		
Hay	300	Total	10,257

IMPORTS.

	Tons.		Tons.
Acids	750	Merchandise (general)	40,000
Apples	72	Oil	517
Bark (tan)	650	Plaster (land)	14
Beer	1,008	Poles (telegraph)	850
Brick	10,200	Potatoes	450
Coal and coke	24,250	Salt	250
Corn	19,600	Sash, doors, and blinds	17
Iron and steel	435	Stone (building)	4,200
Leather	64	Tile	150
Lime and cement	4,016	Timber	900
Lumber	19,965	Wood, fire	300
Marble	5,300		
Marble dust	250	Total	134,171

L L 20.

IMPROVEMENT OF FOX AND WISCONSIN RIVERS, WISCONSIN.

WISCONSIN RIVER.

The subject of the improvement of the Wisconsin River was referred to the Board of Engineers for Fortifications and for River and Harbor Improvements, and the report of the Board was published in House Ex. Doc. No. 65, Forty-ninth Congress, second session. (See Annual Report of the Chief of Engineers, U. S. Army, for the year 1887, Part III, page 2094 and following.)

The Board decided against the application of wing dams as a means of improvement, and recommended that no more work be done. No more work has therefore been done.

FOX RIVER.

Object.—Originally to secure a cheap route of water transportation from the Mississippi River to the Great Lakes and Atlantic seaboard. The improvement of the Wisconsin River having been abandoned, the present object is to obtain a navigable channel as far as existing works will permit, from Portage, on the Wisconsin River, to the harbor of Green Bay, a distance of 160 miles.

Project.—The original project called for slack-water navigation on the Fox River by means of locks and dams as part of the through transportation route. The present modified project is that recommended by the Board of Engineers of May 14, 1886, and is to deepen the Fox River by rock excavation and dredging from Montello to Green Bay to 6 feet depth, and from Portage to Montello to 4 feet depth; to widen the river channels to 100 feet throughout; to deepen the channel between De Pere and Green Bay; to dredge the channel in the Neenah River, and to remove the bar at the mouth of the Fond du Lac River.

Present works.—The present works are as follows:

	Upper Fox.	Lower Fox.	Total.
Locks	9	18	27
Dams	7	10	17
Canals	4	8	12
Revetment walls		2	2
	20	38	58

Of the locks, fourteen are of stone, built by the United States, and one stone lock built by the canal company and repaired in 1878. The remaining twelve are wooden locks which have been rebuilt and repaired from time to time. No more masonry locks are to be built.

Of the dams, 1 is of masonry, 10 of cribs, 1 of pile and cribs, 1 of pile and cribs with movable pass, and 4 of brush and stone.

Of the canals, only the one at Portage is revetted its entire length of about 2 miles, on both sides with a timber revetment.

Of the two revetment walls, one is at Kaukauna and the other at Appleton. The former, about 1,200 feet long, is a dry-laid stone wall, built by the canal company, and may have to be rebuilt, as it shows signs of yielding; the latter is of cement-laid stone masonry, built by the United States in 1878.

Depth of water.—The fall from Menasha to Green Bay is about 170 feet, and on the Upper Fox, from Portage to Lake Winnebago, about 30 feet. Previous to any improvements the river was obstructed by rapids and at places portages had to be made.

During the fiscal year ending June 30, 1891, navigation on the Lower Fox was continued until November 30, 1890, and was resumed April 15, 1891. From July 30 to August 16, 1890, navigation was suspended through the Appleton Fourth Lock during the repairs necessitated by the steamer *K. M. Hutchinson* running into the upper gates.

On the Upper Fox navigation was maintained until closed by ice, December 1, 1890, and was resumed April 21, 1891, and continued until June 1, when the water was so low that navigation was suspended. On many of the bars between Berlin and Montello there is less than 2 feet of water.

Operations during the fiscal year.—A beginning was made in the construction of the guard gates at the head of the Kaukauna Canal; a head wall and feeder built at the head of the old first lock at Appleton; a wing dam of brush and stone, constructed as a shore protection to the Portage Levee to prevent undermining at a point on the Wisconsin River in the town of Portage; a new tugboat and two dump scows were built; channels dredged at Grignon Rapids, at the mouth of Fond du Lac River and between De Pere and Green Bay, and minor repairs made to plant, etc.

For details of the work attention is respectfully invited to the subjoined reports of First Lieut. H. E. Waterman, Corps of Engineers, and of Assistant Engineer Samuel Whitney.

Remarks and recommendations.—This river has its effect upon rates on all freight carried to points in the Fox River Valley, which is the most thickly settled portion of the interior of Wisconsin, and an important manufacturing region. All freights during the season of navigation, and particularly heavy freights, are reduced to near the price of water carriage whether carried by boat or by the competing railroads; and for the reason that it is a regulator of freights it is of such value that the works should be maintained and the navigation improved at least to the extent contemplated by the modified project of 1884.

During the season of 1890 the water has been very low, after August 14 below the crest of the Menasha dam.

During the season of navigation the mill owners have continued, and still continue, to take water from the pools above the Appleton and Menasha dams much in excess of the discharge of the Fox River, thus reducing the levels of Lake Winnebago and Little Lake Butte des Morts below the crests of the dams. This is a constantly growing evil. On the 8th of November, 1886, a suit was filed in equity in the United States court of the eastern district of Wisconsin against the Winnebago Paper Company and some 30 other mill owners at Neenah and Menasha, to restrain them from taking water for hydraulic power or other purposes during the season of navigation from the level of Lake Winnebago above the Government dam at the city of Menasha when the level of the water in said lake is at or below the crest of said dam. The defendants filed their plea, and on March 5, 1887, replication was duly filed. During the spring and summer of 1888 the United States produced witnesses and took testimony from time to time before the master in chancery. The defendants obtained further time in which to put in their proof.

Mr. A. E. Thompson, special assistant United States attorney, whose letter is herewith appended, writes as follows about this suit:

There is also pending a suit in equity, commenced in the United States circuit court for the eastern district of Wisconsin, against the Winnebago Paper Company and some 30 others, mill owners at Neenah and Menasha. If possible the defendants will be required to close their proof during the present summer, so that the matter can be heard by the court either at the October or January term.

Money statement.

July 1, 1890, balance unexpended	\$15,556.01
Amount appropriated by act approved September 19, 1890.....	100,000.00
	115,556.01
June 30, 1891, amount expended during fiscal year.....	39,059.54
	76,496.47
July 1, 1891, balance unexpended	76,496.47
July 1, 1891, outstanding liabilities	2,990.52
	73,505.95
July 1, 1891, balance available.....	73,505.95
<hr/>	
{ Amount (estimated) required for completion of existing project	346,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	200,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF LIEUTENANT H. E. WATERMAN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., June 30, 1891.

MAJOR: I have the honor to submit the following report of improvements carried on in the Wisconsin River during the past year for the purpose of protecting the caving levee at Portage, Wis.

As a result of the high water of last year the levee, last fall, between Superior street and Bronson avenue, Portage, over a distance of 800 feet, was left in a dangerous condition.

The river slope had caved in considerably, the slopes (from about 2 feet below the levee crest) being generally between the above streets greater than one on one. In fact, appearances seemed to indicate that as soon as the frost came out in the following spring a considerable part of the levee might fall into the river through its own weight.

The main cause of this undermining was due to the fact that the main channel of the river at mid stage and above lay close to the levee; in fact, it was confined in a narrow chute about 60 feet wide between the levee and an island, which formerly was part of the mainland.

Apparently also several dams across the river, intended for the Wisconsin River improvement (now abandoned), were aiding in confining the current along the levee.

The first measure adopted was the construction of a wing dam above the island connecting it with the main shore and protecting throughout the caving levee.

The location of this dam is shown on the maps accompanying this report.

A hole of considerable depth existed behind the head of this dam which might eventually injure its stability, but it was hoped that eventually the river sand would fill this up.

This hope seems in a fair way to be realized, judging from the effect of the spring rise as shown on the second map.

The filling amounts to a full foot down nearly to the head of the island. In addition, during this rise the dam protected the levee perfectly. The only damage done was far below the effect of this wing dam.

In addition, last winter gaps were made in two wing dams across the river by the use of dynamite. A tin can containing the cartridge was inserted underneath the dam by means of a hollow gas pipe, and then exploded. The result has been to make a small gap of about 10 feet in the lower dam, and a considerably longer one in the upper. Probably in neither case has more than 3 feet in depth of the dam been removed, and the debris was not washed out by the last rise.

I could discover very little effect from the removal of these dams. The gap at the upper dam, which probably at first had some influence, is now rapidly filling with sand from a neighboring bar, and will soon be nearly as solid as before. The debris is entirely covered with sand already.

Finally, in my opinion, the protecting wing dam has been a complete success, and I believe nothing more will be necessary at this point, though of course it will be necessary to exercise extra watchfulness during the times of high water.

The accompanying maps explain themselves. The first shows the state of affairs before anything was done; the second, after the completion of the wing dam and also after the spring rise.

Very respectfully, your obedient servant,

Maj. CHAS. E. L. B. DAVIS,
Corps of Engineers, U. S. A.

H. E. WATERMAN,
First Lieutenant of Engineers.

REPORT OF MR. SAMUEL WHITNEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Oshkosh, Wis., June 30, 1891.

MAJOR: I have the honor to submit the following report of operations upon the improvement of the Fox River, Wisconsin, from Portage to Green Bay, for the fiscal year ending June 30, 1891.

The principal work done during the year was the building of a head wall and feeder at the head of the old first lock at Appleton; building new tug, and two dump scows; dredging the channel of the river; repairing the plant, etc.

Navigation on the Lower Fox River was continued until November 20, 1890, except from July 30 to August 16, when temporarily suspended through Appleton fourth lock, which was closed for repairs. It was resumed April 15, 1891, and continued to date of this report.

On the Upper Fox River navigation was maintained until closed by ice December 1, 1890, and was resumed April 21, 1891, and continued until June 1, when the stage of water became so low that navigation was suspended. On many of the bars between Berlin and Montello there is less than 2 feet of water.

The following outline of operations between Green Bay and Portage under separate headings, viz, "Improving Fox River," and "Improving Fox and Wisconsin Rivers, Wisconsin," is respectfully submitted.

IMPROVING FOX RIVER, WISCONSIN.

CONSTRUCTION OF LOCKS, ETC.

Guard gates at the head of Kaukauna Canal.—The dressing of stone for the pier and abutments was commenced in March, 1891, and since that date 1,010 superficial feet of bush-hammered face, 1,060 superficial feet of quarry face, 666 superficial feet of coping, and 13 hollow quoins have been dressed. Dredge No. 2 removed 720 cubic yards of clay and gravel from the site of the center pier, all of which was placed in dump scows, towed to deep water above the dam, and dumped. A crib cofferdam, 182 feet in length and 12 feet in height, has been built around the site of the center pier and left abutment, and pumping machinery set in place.

There were purchased and received 29,160 feet B. M. pine lumber, 3,907 pounds iron rods, nuts, and washers, 807 pounds drift bolts, 172 pounds spikes and nails, 21 pounds assorted packing, 5 gallons kerosene oil, 17½ pounds tallow, 7½ tons bituminous coal, and 45 cords of wood.

Construction of head wall and feeder at head of old Appleton First Lock.—During the winter of 1890-'91, a headwall and sluiceway were built at the head of the old first lock at Appleton. Dredge No. 3 removed 20 linear feet of the old retaining wall and built a clay cofferdam from the stone retaining wall to the head of the stone lock. Below the lock a crib cofferdam, backed with clay, was constructed. A pump and engine were set up and the water pumped out of the old lock chamber. One hundred and twenty-three cubic yards of clay and stone were removed from the site of the wall and 293 cubic yards of the masonry of the old lock taken down. Sixty-four corner stones and 8 steps for sluice piers, and 184 superficial feet of stone for the arch over sluiceway were dressed, and 511 cubic yards of cement masonry were laid. A Tainter gate was framed, fitted, and hung in the sluiceway, maneuvering gear set up, and a house built over the gate and gear. The cofferdams were removed by Dredge No. 3, April 6 to 10, completing the work. Of the stone used in the work, 75 cubic yards were brought from the Kaukauna quarry and 20 cubic yards from Little Chute. The remainder of the stone required for the work was taken from the walls of the old first lock.

There were purchased and expended 18,563 feet B. M. pine, and 210 feet B. M. oak lumber, 1,000 shingles, 2,883 pounds wrought and cast iron irons, 579 pounds drift bolts, 28 pounds steel, 492 pounds spikes and nails, 1 pilot wheel, 50 barrels Portland and 410 barrels Louisville cement, 213½ cubic yards sand, 1,000 pounds straw, 22 gallons kerosene oil, 9 gallons lard oil, 5 pounds solder, 5 pounds assorted packing, 12½ pounds white lead, 5 cords wood, and 49,660 pounds bituminous coal.

Portage Levee.—A wing dam was built as a shore protection to the Portage Levee to prevent the further dangerous undermining at a point in the town of Portage. The dam was commenced at a point on the river bank at the foot of Superior street, and extended therefrom a distance of 97 feet into the Wisconsin River, and from thence downstream, on a line parallel with the levee, a distance of 575 feet. The height of the dam when completed was 5 feet above the zero of the Portage gauge.

In order to lessen the current in the Wisconsin River, at a point opposite the Portage Lock, the width of the waterway was increased 120 feet by lowering the old wing dam at that point 3 to 5 feet below the water surface and making an opening 20 feet in width in the second dam below the lock. The work was accomplished by exploding cartridges of *Ætna* powder underneath the dam.

There were purchased and expended 150 pounds of *Ætna* powder, 100 percussion caps, 9½ pounds wire, 220 feet safety fuse, 673 feet tin tubing, 51 feet iron pipe and couplings, 391 cords of stone, 2,347 brush mats, and 1 sand pump.

REPAIRS OF BOATS AND DREDGES.

Tugboat *Boscobel*.—The steamer *Boscobel* was laid up at Berlin, and during the winter the following repairs of machinery were made: The crank shaft was lengthened 12 inches, and provided with a new balance wheel and steel pinion; a new iron bedplate was made for the boxes of the engine and core-wheel shafts; the old cylinder rings, boxes for the cross head end of connecting rod, and keys for the core wheel, were replaced by new ones; the link and link blocks were repaired; the eccentric hubs and yoke trued up; crosshead pin turned true, new short couplings put on the paddle-wheel shaft, and the steam pipes put in good condition. The repairs were completed April 15 and the boat put in commission.

There were purchased and expended 1 cast steel pinion, 1 set cylinder rings, 1 set brass boxes, 1 rocker arm, 2 globe valves, 1 balance wheel, 1 cast-iron plate, 1 check valve, 11 feet iron pipe and fittings, 3½ pounds assorted packing, 120 maple cogs, and 2 water-gauge glasses.

Tugboat *Dekorra*.—The steamer *Dekorra* was hauled out at Appleton and blocked up; graving pieces were put in the bottom, the hull was calked, and rudder repaired. The old smoke pipe, breeching, ash pan, and furnace grates were replaced by new ones; the wrist-pin straps were refitted, new boxes made for wrist pin, and wrist pin turned. A new flue was put in the boiler and the old flues calked. The repairs were completed April 6, 1891, and the boat put in commission.

There were purchased and expended 329 feet B. M. of pine lumber, 395 pounds sheet iron, 14 pounds wrought iron, 4 pounds steel, 4 pounds brass castings, 246 pounds iron castings, 2 boiler flues, 35 pounds spikes and nails, 5 bales oakum, half barrel pitch, 22 pounds tallow, 5 gallons kerosene oil, 5 gallons lard oil, and 9 gallons Eldorado oil.

Steam launch *General Meade*.—The hull was calked, a patch put on the inside sheet of boiler, and slight repairs of the machinery made.

There were purchased and expended 9 pounds nails, 13 pounds tallow, 7 pounds white lead, and 1 set of cylinder rings.

Dump scows Nos. 1 and 2.—The scows were hauled out at Appleton and blocked up; broken planks were removed from the bottoms and replaced by new ones; the decayed deck and pocket planks were taken off and replaced by new pine deck and oak pocket planks; the pocket-door hinges and chains were repaired, new oak fenders made and put in place, and the corner irons taken off, repaired, and replaced. The scows were recalked and launched, completing the repairs.

There were purchased and expended 4,536 feet of pine and 6,500 feet of oak lumber, 332 pounds drift bolts, 800 pounds spikes, 5 bales oakum, 33 pounds tallow, half barrel pitch, and 2 gallons Eldorado castor oil.

Dredge No. 3.—The doors and windows of the cabin were repaired; the old stern spud and one of the wooden arms of the turntable were replaced by new ones; hoisting-chain trough provided with new sides; the valve seats of throttle and globe valves were ground to a fair surface, and the hoisting and swinging engines cleaned, set up, and properly adjusted for work. The dipper teeth were sharpened, dipper bands and lugs riveted, and a new steel plate put on bottom of dipper, completing the repairs. The dredge was put in commission April 6.

There were purchased and expended 1,987 feet B. M. of oak lumber, 453 pounds iron castings, 115 pounds boiler iron, 4 pounds washers, 40 pounds assorted packing, 11½ pounds rope, 5 gallons lard oil, 5 gallons black oil, 5 gallons cylinder oil, and 10 gallons kerosene oil.

Dredge No. 5.—The top sides of the hull and a part of the deck were recalked; spud-chain troughs and gear were repaired; new brass bushings were put in inside end of one of the hoisting drums; one of the valve cranks and the valve rocker of spud engine were provided with new steel pins, and the link trued up. The clam-shell bucket was provided with new steel bushings and pins, and the frame of clam shell with new socket bands. The machinery was cleaned, put together, and properly adjusted, completing the repairs. The dredge was put in commission May 5.

There were purchased and expended, 200 feet B. M. of pine lumber, 260 pounds iron castings, 293 pounds iron and screw bolts, 25 pounds nails, 2 bales of oakum, 1 barrel pitch, 567 pounds blacksmith coal, and 12,920 pounds bituminous coal for the steamer *Boscobel*.

Dredge No. 7.—The top sides of hull were recalked; the old sheaves of turntable and backing chain were taken out and were replaced by new ones and the shaft boxes of the sheaves babbitted. Dipper teeth were repaired and new steel friction plates put on dipper handle. The hoisting and swinging engines were cleaned and put together, boom, dipper handle, hoisting and backing chains put in place. The repairs were completed May 6 and the dredge put in commission.

There were purchased and expended 1,290 pounds steel, 1,396 pounds iron castings, 254 pounds iron and screw bolts, 40 pounds babbitt metal, 19½ pounds assorted packing, 1 new steam cylinder, 10 pounds cotton waste, 2 bales oakum, 5 gallons kerosene oil, 300 pounds blacksmith coal, and 7 tons bituminous coal for the steamer *Boscobel*.

CONSTRUCTION OF BOATS, ETC.

Propeller tugboat.—During the winter of 1890-'91, a tugboat to act as tender to dredges, etc., was built at Oshkosh, Wis. The dimensions of the hull are as follows, viz: Length of keel 63 feet 7 inches, length on deck 69 feet, breadth of beam 13 feet 6 inches, and depth 6 feet. The frames are made of two thicknesses of 3-inch fitch, bottom planking 2½ inches, top side planking 2½ inches, and ceiling 2 inches in thickness. The boat was completed and put in commission April 13, 1891.

There were purchased and used in the construction, machinery, and other materials as follows, viz:

One marine boiler 5 by 10 feet, 1 upright marine engine 12 inches bore and 14 inches stroke, 1 propeller wheel 4 feet 6 inches diameter, 1 windlass, 1 heater, 1 side pump, 1 bilge pump, 1 double-acting deck pump, 1 oil pump, 1 injector, 1 pinch wheel and levers, 1 pop safety valve, 2 steam gauges, 1 whistle, 1 locomotive gong, 1 1-pint lubricator, 1 3-way exhaust shifter, 2 siphons, 1 stern pipe and stuffing box, 1 double pushbearing, 1 double-acting steam pump, 322 feet iron pipe and fittings, 3,118 feet feet B. M. of pine, 16,792 feet B. M. of oak and 47 feet B. M. of maple lumber, 500 linear feet of molding, 8 doors, 15 windows, 354 pounds iron castings, 2,217 pounds wrought iron for bolts, rods, and straps, 888 pounds sheet iron, 116 pounds steel, 27 pounds washers, 1,000 pounds boat spikes, 134 pounds nails, 506 pounds chain, 21 pounds sheet zinc, 7½ pounds sheet copper, 4½ squares tin roofing, 27 pounds spun cotton, 4 bales of oakum, 20 pounds putty, 50 pounds tallow, 50 pounds grease, 15 barrels salt, 1 barrel lime, 75 fire brick, 50 pounds fire clay, 5 pounds red paint, 5 pounds yellow ochre, 50 feet 1½-inch rubber hose and nozzle, 25 feet ¾-inch cotton hose and nozzle, 97 pounds rope, and 1 anchor.

Two center-dump scows.—Two center-dump scows, 18 by 68 by 6 feet, having a carrying capacity of 65 cubic yards each, are under construction. No. 1 scow is nearly completed and No. 2 about half built.

There were purchased and received 35,381 feet B. M. of pine and 14,281 feet B. M. of oak lumber; 2,756 pounds iron for drift bolts, etc.; 255 pounds screw bolts and washers 1,200 pounds spikes, and 5 bales of oakum.

DREDGING LOWER FOX RIVER.

Deepening channel at Grignon Rapids above the upper dam at Appleton.—Four cribs, 8 feet square and 8 feet in height, to mark the line of channel to be dredged, were built, sunk in place, and filled with stone. Dredge No. 2 commenced the work of dredging the channel on May 25, 1891. A cut 795 feet in length, 30 feet in width, and a depth of 7 feet below the level of the crest of the dam, has been made, from which 3,685 cubic yards of hard pan, gravel, and bowlders have been excavated and banked at the left side of the cut.

There were purchased and received 179 pounds iron, 80 pounds steel, 18 pounds assorted packing, 4 pounds marlin, 109 pounds cotton waste, 5 gallons kerosene oil, 50 gallons Eldorado castor oil, 29 gallons cylinder oil, 163 pounds iron castings, 110 cords of wood, and 6,800 pounds bituminous coal.

Dredging Neenah Channel.—August 30, 1890, Dredge No. 3 and 2 dump scows were towed to Neenah River, and dredging of the channel was resumed September 1.

Thirteen thousand four hundred and forty-five cubic yards of hard pan and gravel were removed, of which 630 yards were banked, 2,605 yards put in dump scows, towed to the rear of Neenah Dam for backing, and the remainder towed to deep water in Lake Winnebago and dumped. Dredging was suspended November 3 and the plant towed to Appleton Fourth Lock.

April 23, 1891, the dredging was resumed by Dredge No. 3, and up to date of this report 8,406 cubic yards of hard pan and gravel have been taken out, of which 1,593 cubic yards were banked, 4,438 yards put in dump scows, towed to deep water in Lake Winnebago and dumped, and the balance deposited in rear of Neenah Dam for backing.

There were purchased and received 20 pounds steel, 2 cast-steel endless chain wheels, 88 pounds iron castings, 407 pounds iron, 40 pounds spikes and nails, 25 pounds nuts, 469 feet iron pipe and fittings, 1 injector, 9 pounds assorted packing, 5 water-gauge glasses, 115 pounds rope, 28 gallons kerosene oil, 52 gallons lard oil, 50 gallons Eldorado castor oil, 5 gallons boiled linseed oil, 115 pounds cotton waste, 478 pounds blacksmith coal, 145½ cords of wood, 103 tons bituminous coal, and 210 feet of dredge chain.

Dredging channel at the mouth of Fond du Lac River.—Dredge No. 7 was towed to Fond du Lac May 13, 1891, and commenced the work of dredging a channel through the bar at the mouth of the river. One cut 1,705 feet in length, 35 feet in width, and of a depth of 7 feet below the level of the crest of the dam at Menasha, has been made through the bar, from which 8,319 cubic yards of sand and clay were removed and banked at the left side of cut. The dredge then moved back to the mouth of the river and commenced the second cut. Nine thousand one hundred and seventy-four cubic yards of clay and sand have been removed, placed in dump scows, towed to deep water in Lake Winnebago, and dumped.

There were purchased and received 189 pounds rope, 2 pounds marlin, 113 pounds cotton waste, 51¾ gallons Eldorado castor oil, 17 gallons lard oil, 26 gallons cylinder oil, 100 feet dredge chain, 17 pounds oakum, 97½ cords of wood, and 33,960 pounds bituminous coal.

IMPROVING FOX AND WISCONSIN RIVERS.

DREDGING FOX RIVER BETWEEN DE PERE AND GREEN BAY, WISCONSIN.

Dredge No. 2 having returned from temporary work in Green Bay Harbor, July 1, 1890, resumed dredging at the bar opposite Goodrich's Wharf; 4,214 cubic yards of sand were removed therefrom, and the dredge then moved down to the bar at Dutchmans Creek, and took out 4,931 cubic yards of sand, completing the dredging of a channel through the above bars. On August 15 the dredge moved down to the bar opposite the brewery, on the right bank of the river, and took out 6,726 cubic yards of very soft material, completing the second cut through the bar. All of the material excavated was placed in dump scows, towed to deep water in the river by the steam-launch, and dumped. Dredging was suspended on the 15th of September, and the dredge towed to De Pere Dam.

There were purchased and expended 14 pounds rope, 10 pounds steel, 701 pounds iron castings, 14 pounds wrought iron, 840 feet B. M. of oak lumber, 4 water gauge glasses, 10 gallons kerosene oil, 400 pounds blacksmith coal, 12,540 pounds anthracite coal, and 9 cedar posts for buoys.

MISCELLANEOUS.

The tugboat *Boscobel* was employed in towing dredges on the Upper Fox River from place to place, in supplying them with fuel, and in towing scows of material for repairs of locks and dams, and on inspection trips.

The tug-boat *Dekorra* towed dump scows for Dredge No. 3 on the Lower Fox River and made inspection trips.

The steam-launch was employed in towing dump scows for Dredge No. 2 on the Lower Fox River, in towing scow loads of material for repairs of locks and dams, and making inspection trips.

The tugboat *General G. K. Warren* was employed in towing dredges on the Lower Fox River, towing scow loads of material for the construction of guard gates at Kaukauna, and in towing dump scows at Fond du Lac for Dredge No. 7.

The steamer *Henrietta*, which has not been in commission since November 20, 1886, was sold at public auction on the 17th of September, 1890.

One rowboat for general use on the Lower Fox River was purchased.

No. 3 pump engine and pump.—The cylinder was rebored; new cylinder rings, governor, safety valve, and gauge cocks were provided for the engine, and all parts of the engine put in good repair. A new fire box, fire front, furnace door lining, and

flue sheet for the boiler were made and put in place of old ones; the wagon on which the engine is carried was provided with a new pole, and the wagon painted one coat. A new steel step, box, and couplings were provided for the 10-inch centrifugal pump, completing the repairs.

There were purchased and expended 1 pop valve, 2 gauge cocks, 1 governor, 12 feet rubber belting, 110 feet iron pipe and fittings, 592 pounds steel, 381 pounds wrought iron, 566 pounds iron castings, and 58 pounds galvanized iron.

Care of property.—A room was partitioned off at one end of the warehouse at Kaukauna, and the property stored on the quarter-boat transferred to the room in the warehouse.

Very respectfully, your obedient servant,

SAMUEL WHITNEY,
Assistant Engineer.

Maj. CHAS. E. L. B. DAVIS,
Corps of Engineers, U. S. A.

REPORT OF MR. A. E. THOMPSON, SPECIAL ASSISTANT UNITED STATES ATTORNEY.

OSHKOSH, WIS., June 20, 1891.

MAJOR: Of the one hundred and fifty-six cases pending June 18, 1890, in the circuit court of Winnebago County against the United States, on appeal from the awards made by the commissioners, all except five have been disposed of.

Five of these cases were tried at the September term, 1890; in four judgment was entered in favor of the United States; in one, judgment for the claimant.

In the other cases disposed of, judgments were entered against the United States upon stipulations pursuant to settlements and compromises made by consent and direction of the Attorney-General.

The aggregate amount claimed in the cases thus disposed of was \$744,615. The aggregate amount of the awards was \$111,045.32. The aggregate amount of the judgments is \$107,962.33.

Of the nine cases pending in Fond du Lac County at that date, the appeal in one was dismissed by stipulation, and in two by the order of the court, and six are still pending and undetermined.

All cases at issue have been transferred to the circuit court of the United States for the eastern district of Wisconsin, pursuant to the provisions of the act of September 30, 1890. These include the five cases formerly pending in Winnebago County, six in Fond du Lac County, one in Outagamie County, and one in Waushara County, making thirteen cases now pending, in which the aggregate amount claimed is \$210,818, and the aggregate amount awarded is \$124,904.02.

I expect to dispose of these cases, or at least some of them, at the October term of the court, and I estimate that \$7,000 will be used in the necessary preparation and defense of these actions.

There are also pending in the State courts various motions for relief by claimants who failed to appeal within the time or whose petitions have been in some way overlooked by the commissioners. Thus far the decisions have been uniformly in favor of the United States.

There is also pending a suit in equity, commenced in the United States circuit court for the eastern district of Wisconsin, against the Winnebago Paper Company and some thirty others, mill owners at Neenah and Menasha. If possible, the defendants will be required to close their proof during the present summer, so that the matter can be heard by the court either at the October or January term.

During the past year I have delivered to the parties entitled thereto, Treasury drafts, drawn pursuant to the appropriation of September 30, 1890, to the amount of \$156,552.70 and taken proper receipts and satisfactions therefor. Of this amount \$35,362.50 was paid to the commissioners appointed by the courts; \$787.50 was paid to Mr. E. E. Chapin for office rent, and the balance in settlement of awards for damages in cases where no appeals were taken.

Very respectfully yours,

A. E. THOMPSON,
Special Assistant United States Attorney.

Maj. CHAS. E. L. B. DAVIS,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

List of articles transported on Fox River, Wisconsin, during the calendar year 1890.

Article.	Tons.	Article.	Tons.	Article.	Tons.
Logs	211,350	Pig-iron	2,888	Grain	30
Lumber	8,976	Stone	23,146	Potatoes	150
Cord wood	28,668	Gravel	1,560	Apples	23
Pulp wood	33,446	Sand	17,528	Cranberries	40
Shingles	1,354	Lime	5,990	Beer	33
Laths	18	Brick	35,034	Fish	75
Slave bolts	506	Sewer pipe	400	Live stock	200
Pine slabs	600	Salt	2,005	General merchandise	2,510
Boom sticks	5	Flour	158		
Coal	10,900	Mill stuffs	1,702	Total	389,291

Passengers, 20,760.

List of boats navigating Fox River between Portage and Green Bay, Wis., June, 1891.

Name of boat.	Draft.	Ton-nage.	Steam or sail.	Name of boat.	Draft.	Ton-nage.	Steam or sail.
	<i>Feet.</i>				<i>Feet.</i>		
Evalyn	5½	150.66	Steam.	D. W. Cady (tug)	2	20	Steam.
K. M. Hutchison	4½	189.96	Do.	Oshkosh (tug)	3	46	Do.
Fashion	3½	70	Do.	Emma (scow)	4½	35	Sail.
City of Berlin	3	150	Do.	Georgie (scow)	5½	82	Do.
B. F. Carter	5	125	Do.	Topsy (scow)	4½	72	Do.
Ossian Cook	5	175	Do.	Julia (scow)	5	44	Do.
C. S. Morris	3½	100	Do.	Sassy Jack (scow)	4	26	Do.
J. H. Marston	4½	150	Do.	Rosebud (scow)	5	75	Do.
Mark	2½	30	Do.	Eclipse (scow)	3½	60	Do.
O. B. Reed	3	75	Do.	Barge (Morning Bell)	3½	70	Tow.
John Lynch	3	50	Do.	Barge (Mark)	2½	90	Do.
Morning Bell (tug)	5	9	Do.	Barge (D. W. Cady)	4	75	Do.
Viola (tug)	3½	7	Do.	Barge Jumbo*	4½	97	Do.
Thos. Spear (tug)	10	41	Do.	Barge No. 1*	5	145	Do.
Agnes C. (tug)	6	7	Do.	Barge No. 2*	5	145	Do.
W. W. Neff (tug)	3½	46.44	Do.	Barge No. 3*	5	145	Do.
M. D. Moore (tug)	3½	60	Do.	Barge No. 4*	5	145	Do.
D. W. Libby (tug)	3½	60	Do.				

* H. Collette.

Number of lockages on Fox River, Wisconsin, for the calendar year 1890.

No.	Lock.	Lock-ages.	No.	Lock.	Lock-ages.
1	De Pere	700	16	Appleton, second	406
2	Little Kaukauna	657	17	Appleton, first	564
3	Rapid Croche	547	18	Menasha	773
4	Kaukauna, fifth	696	19	Eureka	649
5	Kaukauna, fourth	747	20	Berlin	625
6	Kaukauna, third	674	21	White River	180
7	Kaukauna, second	686	22	Princeton	165
8	Kaukauna, first	706	23	Grand River	396
9	Little Chute, fourth } Combined	469	24	Montello	158
10	Little Chute, third }	469	25	Governor Bend	98
11	Little Chute, second	417	26	Fort Winnebago	185
12	Little Chute, first	418	27	Portage City	51
13	Cedars	405			
14	Appleton, fourth	350		Total	12,634
15	Appleton, third	403			

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OPERATING AND CARE OF LOCKS AND DAMS ON FOX RIVER, WISCONSIN.

The expenditures for maintaining the existing depth of navigation throughout the Fox River and canals; for repairs to mechanical constructions that have been completed and in use, but afterwards injured

by flood or otherwise; for current repairs to old locks and dams, and for lock-tenders' services, have been paid from the indefinite appropriation for "operating and care of canals and other works of navigation," provided by section 4 of the river and harbor act of July 5, 1884.

In accordance with this section an itemized statement of the expenditure is appended herewith.

Work during the fiscal year ending June 30, 1891, consisted of building and hanging two new gates for the lock at De Pere; four new gates for the fourth lock at Appleton, and four for the Eureka Lock; extensive repairing of the Appleton fourth lock, necessitated by the carrying away of the upper gates by the steamer *K. M. Hutchinson*; in rebuilding Dredges Nos. 2 and 4; repairing plant and making more or less extensive incidental repairs to locks, dams, and canal banks.

For details of the work attention is respectfully invited to the appended report of Mr. Samuel Whitney, assistant engineer.

Money statement.

June 30, 1891, amount expended during fiscal year.....	\$68,989.00
Amount (estimated) for expenditure in fiscal year ending June 30, 1892..	63,998.29

REPORT OF MR. SAMUEL WHITNEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Oshkosh, Wis., June 30, 1891.

MAJOR: I have the honor to submit the following report of operations under the head of operating and care of canals and other works of navigation on the Fox River for the fiscal year ending June 30, 1891,

The principal work done during the year was building and hanging two new gates for De Pere and four for Appleton Fourth Locks, making four new gates for Eureka Lock; rebuilding Dredges Nos. 2 and 4, repairing the plant, and making incidental repairs of locks, dams, and canal banks.

De Pere Lock and Dam.—New solid gates for the upper end of lock were built, the old ones taken out and the new ones hung in place; hand rails, maneuvering gear, and fenders were made and secured to gates. The canal face of the upper left wing wall was sheathed with two thicknesses of pine plank.

A leak near the right abutment of the dam was stopped by placing and puddling 360 cubic yards of clay.

There were purchased and expended 7,816 feet, B. M., of pine and 2,052 feet, B. M., of oak timber, 2,356 pounds of T and strap iron, 5,060 pounds iron castings, 25 pounds iron, and 224 pounds screw bolts.

Little Kaukauna Lock and Dam.—Slight repairs were made to the toe post of the upper left gate, one new snubbing post set, and one capstan platform repaired. The old planking of 160 linear feet of the apron of the dam was replaced by new white-oak plank. The repairs of the backing of the dam were completed by filling the low places with 1,360 cubic yards of clay.

There were purchased and expended 7,200 feet, B. M., of white-oak plank, 388 feet, B. M., of pine plank, 600 pounds of spikes, and 4 tons of anthracite coal for the steam launch.

Rapid Croche Lock and Dam.—The lower miter sill and the floor of the lock chamber having risen from 3 to 6 inches made it necessary to pump the water out of the lock so that repairs could be made. Timber and stone for cofferdams were transported from Menasha and Appleton, and on the close of navigation, November 20, 1890, the work of constructing cofferdams above and below the lock was commenced. The dams were completed in December; pumping engine, pump, etc., set up and the water pumped out of the lock. Old floor planks at the lower gate recess, and for a width of 3 feet 6 inches along the center of the lock chamber, the lower miter sills, and platform under the miter sills were taken up and removed from the lock. A crib 6 feet 9 inches wide, 6 feet high, and 29 feet long, to which the miter sills could be secured, was built, placed in a trench excavated for its reception, and filled with stone. The upstream side of the crib was sheet piled with two thicknesses of 2-inch plank, reaching to a depth of 2 feet below bottom of crib; the space between

side of pit and the sheet-piling was then filled with clay puddle, and the pockets at the ends of crib with concrete. The floor was relaid, new cheek pieces and king post for miter sills made and secured to crib by ten screw bolts $1\frac{1}{2}$ inches in diameter. A row of piles, to anchor the floor of the lock chamber, was driven along the longitudinal axis of the lock. The piles were driven at distances of 4 feet from centers, and to a depth of 14 feet into the ground, then cut off at a level with the under side of floor and provided with joint bolts which projected 8 inches above the tops of piles. The floor was relaid and secured in place by binders and the joint bolts in tops of piles. The gates and valves were repaired and hung in place, and the lower left crib wall raised about 2 feet and filled with stone. The repairs were completed, the pump removed from lock, and the force discharged February 20. On April 11, 1891, Dredge No. 3 was towed from Appleton to Rapid Croche Lock by the steamer *De-korra*, and commenced the removal of the cofferdams, which was completed on the 18th and the lock opened to navigation.

Forty linear feet of brush mats and 1,580 cubic yards of clay were placed at the back of the dam, completing the repairs of the backing.

There were purchased and expended 30,019 feet, B. M., of pine lumber, 1,200 pounds spikes, 1,518 pounds drift bolts, 2,118 pounds screw bolts, 20 barrels Louisville cement, 39 piles, 30 cords of wood, 16,550 pounds bituminous coal, 14,270 pounds anthracite coal, and 200 pounds blacksmith coal.

Kaukauna Fifth Lock.—Two gate spars were made and placed.

There were purchased and expended 180 feet, B. M., pine lumber.

Kaukauna Fourth Lock.—The joints of 7,000 superficial feet of the wall were raked out and repointed with Portland cement; the gate hangings were repaired and two gate spars made and placed. In order to stop the leaking of water underneath and through the old upper left wing wall an excavation was made to the solid rock and a new wall of cement masonry built in front of and against the old dry wall; 44 cubic yards of clay and 84 cubic yards of loose rock were excavated from the site of the new wall; 192 cubic yards of cement masonry and 64 cubic yards of dry masonry were laid in the wall, and 92 cubic yards of clay puddled in rear of the old wall. The stone used in the wall was taken from that removed from the rock cut in the third level of the canal.

There were purchased and expended 225 barrels Louisville cement, 22 cubic yards of sand, 2 cords of wood, and 180 feet B. M. of pine lumber, and 2 barrels Portland cement for repointing lock walls.

Kaukauna Third Lock.—The joints of 6,200 superficial feet of the lock walls were raked out and repointed with Portland cement, and a leak near the head of the lock was stopped by placing and puddling 60 cubic yards of clay.

There were purchased and expended 2 barrels Portland cement.

Kaukauna Third Level.—A channel 49 feet in width, 200 feet in length, and 18 inches in depth was excavated through the rock bar below the second lock. The bottom of the channel is now 6 to 8 inches below the level of the top of the lower miter sill of the second lock. Boats drawing 6 feet of water can pass through the level without touching bottom. A part of the stone taken out of the channel was used in rebuilding the wing walls of the second and fourth locks, and the remainder piled on the canal bank near the head of the third lock.

There were purchased and expended 300 pounds *Ætna* powder, 400 percussion caps, and 1,000 feet of safety fuse.

Kaukauna Second Lock.—The old upper right wing wall of dry masonry was replaced by a wall of cement masonry. Sixty-six cubic yards of cement and 4 cubic yards of dry masonry were laid in the new wall. A leak near the head of the lock was stopped by placing and puddling 60 cubic yards of clay, and the low places in the backing of the lock walls filled with 300 cubic yards of clay and gravel.

There were purchased and expended 40 barrels Louisville cement and 4 cords of wood.

Kaukauna Second Level.—Seventy-eight cubic yards of stone and rubbish were removed from the level, and the culvert in the right bank closed by plank and 30 cubic yards of clay.

There were purchased and expended 246 feet B. M. of pine lumber.

Kaukauna First Lock.—The joints of 5,050 superficial feet of the lock walls were raked out and repointed with Portland cement, completing the repairs.

There were purchased and expended 2 barrels Portland cement.

Kaukauna Canal Banks.—A leak in the bank of the Fifth Level was stopped by puddling 325 cubic yards of clay, and the weak places in the Fourth Level strengthened by 232 cubic yards of clay and gravel.

Kaukauna Dam.—The right abutment was backed up with 740 cubic yards of clay, and the low places in the backing of the dam filled with 300 cubic yards of clay, completing the backing.

There were purchased and expended 467 feet B. M. oak and 1,595 feet B. M., of

pine lumber for run plank and repairs of scows, 1 ton anthracite and 2 tons bituminous coal for boats.

Little Chute Combined Locks.—The joints of 10,500 superficial feet of the walls were raked out and repointed with Portland cement. Two new gate spars were made and placed.

There were purchased and expended 3 barrels of Portland cement.

Little Chute Second Lock.—The joints of 5,000 superficial feet of walls were raked out and repointed with Portland cement. Two barrels of cement were purchased and expended.

Little Chute First Lock.—Timber for repairs of the coping was brought from De Pere and Little Kaukauna. One hundred and eighty-one linear feet of the old coping, including cross ties and rear pieces, were removed and replaced by new timbers; two gate spars were made to replace broken ones, completing the repairs.

There were purchased and expended 180 feet B. M. of pine lumber.

Little Chute Dam.—No repairs were made to this dam during the year.

Cedars Lock and Dam.—No repairs were needed to the lock. Soundings were taken above the dam; 60 linear feet of brush mats made and sunk in places where the backing had been washed out, and 1,740 cubic yards of clay deposited on the mats completing the repairs to the backing.

Appleton Fourth Lock.—On the 30th of July, the steamer *K. M. Hutchinson*, on her up trip, ran into the upper gates, forcing them open and damaging the right gate beyond repair. The left lower gate was forced out of place by the rush of water through the lock, and carried downstream about 200 feet. Material was collected and the work of repairs commenced on the day of the accident. A cofferdam, 130 feet in length and 8 feet in height, was built, and the water shut out of the canal. A large amount of stone that had been washed into the lock and lodged against the lower miter sill was removed by a hand dredge. The left lower gate was recovered, repaired, and relung. The ironwork of the left upper gate was repaired, two new arms put in, and the gate hung in place. A new solid timber gate was built, and hung in place of the old right upper gate. Three diamond blocks and one capstan platform were made and placed, completing repairs of the lock. On the 16th of August, Dredge No. 3 made a sufficient opening through the cofferdam to admit the passage of boats, and navigation was resumed on that date. The cofferdam was entirely removed on the 19th of August.

After the close of navigation, November 20, 1890, the three old gates, temporarily repaired at the time of the accident, were taken out, valves, valve rods, suspension straps, and other ironwork removed and placed on new gates and the gates hung in place of the old ones. The capstan platforms were repaired and two new gate spars made.

There were purchased and expended 19,030 feet B. M. pine and 3,081 feet B. M. oak lumber, 500 pounds nails and spikes, 656 pounds drift bolts, 398 pounds wrought iron, 316 pounds bar iron, 549 pounds screw bolts and washers, 2,356 pounds T-irons and straps, 7,550 pounds cast-iron gate weights, 227 pounds iron castings, 12 cords of wood, and 4 tons of bituminous coal.

Crib pier between the lower end of the left wing wall of the Appleton Third Lock and the upper end of the center pier of the drawbridge of the Milwaukee, Lake Shore and Western Railway.—Eighty linear feet of cribs 6, to 8 feet in height and 8 feet in width, were built, sunk in place, and filled with stone. Coping timbers, 8 by 10 inches, for the entire length of pier, 112 feet, were framed and bolted in place, completing the work. Of the stone used 10 cords were brought from Appleton Lower Dam and the remainder from Menasha.

There were purchased and expended 384 pounds drift bolts.

Appleton Third Lock.—No repairs were needed.

Waste weir above Appleton Third Lock.—The rotten planks on the sides of walls were removed and replaced by new ones, and the sink holes in the bank at both sides of the weir were filled with 20 cubic yards of gravel, completing the repairs.

There were purchased and expended 665 feet B. M. of tongued and grooved pine plank.

Appleton Second Lock.—No repairs were needed.

Appleton First Lock (old).—The decayed timbers and planks were removed from a section, 12 by 70 feet, of the left wall and replaced by new timbers; 97 cubic yards of the dry masonry of the same wall were taken down and rebuilt, 19 cubic yards of which were laid in cement, so as to make a water-tight connection with the new head-wall. The valves, valve rods, etc., were removed from the lower gates, completing the repairs.

There were purchased and expended 220 pounds spikes and nails, 3,600 feet B. M. pine plank, and 17 cubic yards of sand.

Appleton First Lock (new).—The upper left capstan platform, which had become badly decayed, was replaced by a new one.

Appleton Upper Dam (sluice gates).—The old Howe trusses supporting the beam to

which the gates were hung were removed and replaced by new trussed beams of oak 16 inches square. All of the gates (five in number) were provided with new arms, braces, trunnions, and saddles; the decayed timbers of the winch track were replaced with new timbers, and slight repairs made to the footwalk over the sluices.

There were purchased and expended 8,592 feet B. M. pine, 4,693 feet B. M. oak lumber, and 8,589 pounds iron castings, straps, rods, etc.

Menasha Lock and Dam.—No repairs were required.

Eureka Lock.—All of the lock wall coping was removed, the walls leveled up, and the coping relaid; the walls at the head of the lock, for a distance of 8 feet from the upper end of the gate recess, were raised 16 inches; the joints of 2,500 superficial feet of the lock walls were raked out and repointed with Portland cement, and the low places in the backing of the lock filled with 105 cubic yards of gravel. Ten guard piles were driven at the head and 4 at the foot of the lock; the piles at the head of the lock were provided with 12 by 12 inches oak fenders and chocks, which were fitted and bolted to the piles with 1½-inch screw bolts. Slight repairs were made to the gates, 2 new gate spars made, 1 capstan platform repaired, and 3 new snubbing posts set. During the past winter 4 new solid gates have been built ready to hang in place.

There were purchased and expended 14 oak piles, 5,800 feet B. M. oak timber, 10,506 feet B. M. pine timber, 4 barrels Portland cement, 40 barrels Milwaukee cement, 6 lock valves, 8 spar rollers, 5,078 pounds iron castings, 6,385 pounds wrought iron bolts, straps, and rods, and 7 tons bituminous coal.

Eureka lock house.—The outside of house was painted one coat, and a new galvanized iron chimney top put on one of the chimneys.

There were purchased and expended 8 gallons mixed paint, 1½ gallons boiled linseed oil, and 21 pounds galvanized iron.

Eureka Dam.—A leak near the left end of the dam was stopped with 12 brush mats, 40 cubic yards of gravel, and 160 cubic yards of clay.

Berlin Lock and Dam.—Ten guard piles were driven at the head and four at the foot of the lock; the piles at the head of the lock were provided with oak fenders and chocks of 12 by 12 inches oak timbers which were fitted and bolted to the piles with 1½-inch screw bolts. Nothing done to the dam.

There were purchased and expended, 14 oak piles and 1,320 feet B. M. of oak timber.

White River Lock and Dam.—Ten guard piles were driven at the head and four at the foot of the lock; the piles at the head of the lock were provided with oak fenders and chocks of 12 by 12 inch oak timbers which were fitted and bolted to the piles with 1½-inch screw bolts. Nothing done to the dam.

There were purchased and expended 14 oak piles and 1,320 feet B. M. of oak timber.

Princeton Lock and Dam.—Ten guard piles were driven at the head and four at the foot of the lock; the piles at the head of the lock were provided with oak fenders and chocks of 12 by 12 inch oak timbers which were fitted and bolted to the piles with 1½-inch screw bolts. Nothing done to the dam. There were purchased and expended 14 oak piles and 1,320 feet B. M. oak timber.

Grand River Lock and Dam.—No repairs were needed.

Montello Lock and Dam.—Nothing done to the lock. A leak in the dam was stopped by 25 brush mats and 25 cubic yards of gravel.

Governor Bend Lock and Dam.—No repairs were required.

Fort Winnebago Lock.—Four guard piles were driven at the foot of the lock.

There were purchased and expended 4 oak piles.

Canal at Portage.—Nothing done to the canal during the year.

Guard-lock at Portage.—No repairs needed during the year.

Portage Levee.—Slight repairs were made to the embankment at two or three places within three-fourths of a mile of the lock.

There were purchased and expended 2,445 feet B. M. pine lumber.

Lock-tenders' offices.—Buildings 10 by 12 feet, to answer the purpose of tool houses and offices for lock tenders, were built at Appleton first, Little Chute Combined, Rapid Croche, and Little Kaukauna Locks.

There were purchased and expended, 6,349 feet B. M. pine lumber, 4 doors, 4 windows, and 270 pounds nails.

REPAIRS OF BOATS AND DREDGES.

Ninety-foot drill scow.—The calking of the deck was finished and the grousers shipped, completing the repairs. The scow was towed to Appleton by the steamer *Dekorra* on July 5, 1890.

There were purchased and expended 3 bales of oakum, 36 pounds spun cotton, 2 gallons boiled linseed oil, and 35 pounds screw bolts and washers.

Forty-eight-foot scow.—The calking of the deck was finished, four chocks made and

bolted in place, and one coat of paint put on the sides and ends. The repairs were completed and the scow launched on the 11th of July.

There were purchased and expended 3,386 feet B. M. pine lumber, 294 pounds wrought iron, 109 pounds screw bolts and washers, 216 pounds spikes and nails, 2 bales oakum, 1 barrel pitch, 20 pounds black paint, 3 gallons boiled linseed oil, and 30 pounds tallow.

Dredge No. 7.—The cabin, A-frame, and top sides of hull were painted one coat. There were purchased and expended 50.8 gallons boiled linseed oil, 100 pounds white lead, and 5 pounds lampblack.

Dredge No. 2.—October 16, 1890, the dredge having completed the work of dredging the river outlet of the Combined Lock, was towed to Appleton by the steam launch; the outfit was removed and stored in the warehouse, and on the 19th of the month the dredge was towed to Oshkosh by the tugs *Boscobel* and *Dekorra* for repairs. During the winter of 1890-'91 a new hull, 30 by 80 by 7 feet, was built, the cabin repaired and enlarged; a new crane, dipper handle, spuds, and turntable made; new machinery for hoisting the spuds by steam was put in, and all of the old machinery put in good repair; a new tin roof was put on the cabin, and the cabin, hull, and crane painted one coat. The repairs were completed April 12, 1891, and the dredge towed to Kaukauna.

There were purchased and expended 29,155 feet B. M. pine and 40,361 feet B. M. oak lumber, 60 tamarack knees, 10,203 pounds wrought iron for drift and screw bolts, rods, straps, shafting, etc., 4,469 pounds screw bolts and washers, 125 pounds Norway iron, 9 pounds Russia iron, 30 pounds galvanized iron, 4,432 pounds iron castings, 217 pounds steel, 11 pounds nuts, 130 pounds aluminum bronze castings, 4 pounds sheet brass, 28 pounds sheet copper, 11 pounds zinc, 95 pounds Babbitt metal, 27 pounds lead pipe, 2,727 pounds spikes and nails, 9 gross screws, 180 feet iron pipe and fittings, 15 $\frac{3}{4}$ squares tin roofing, 32 pounds assorted packing, 352 pounds rope, 21 bales oakum, 1 barrel pitch, 1 barrel mortar, 5 barrels salt, 8,700 deck plugs, 200 bricks, 5 gallons kerosene oil, 51 gallons boiled linseed oil, 104 pounds brown paint, 95 $\frac{1}{2}$ pounds black paint, 500 pounds white lead, 120 pounds tallow, 1 ton blacksmith coal, 5,240 pounds bituminous coal, and one wrought-iron crane mast and connections.

Dredge No. 4.—The machinery was removed from the old hull at Berlin and taken to Oshkosh in October, 1890. A new hull, 32 by 90 by 7 feet, has been built and launched. The cabin has been nearly finished; new crane and turntable have been made and put in place, and the dipper handle and spuds nearly completed. The old machinery and boiler have been put in good repair and set up in the new boat; new machinery for hoisting the spuds by steam has been made and set in place. The hull and outside of cabin have been painted one coat. The following new machinery, necessary to change the dredge from a clam-shell to a scoop-dipper one, has been purchased and put in place, viz: 1 hammered iron crane mast, 1 wrought-iron turntable, 1 swinging shaft and connections, 1 pair 7 by 12 inches swinging engines, 1 47-cubic feet scoop dipper, steel racks for dipper handle, endless chain for turntable, 1 dipper-handle pinion, and all the necessary bolts, sheaves, etc., for the crane.

There were also purchased and received 43,090 feet B. M. pine, 45,222 feet B. M. oak, and 39 feet B. M. maple lumber, 24 tamarack knees, 6,586 pounds iron castings, 10,020 pounds wrought iron for rods, straps, drift and screw bolts, 5,477 pounds screw bolts, 149 pounds drift bolts, 473 pounds steel, 900 pounds cold rolled shafting, 154 pounds sheet iron, 79 pounds washers, 8 pounds Norway iron, 2,025 pounds spikes and nails, 140 pounds aluminum bronze castings, 13 pounds assorted packing, 1 blacksmith forge, 21 bales oakum, 2 barrels pitch, 121 pounds tallow, 500 pounds white lead, 91 $\frac{1}{2}$ pounds Victoria black, 25 pounds ship black paint, 50 pounds brown paint, 51 gallons boiled linseed oil, 3 gallons black oil, 1 ton blacksmith coal, and 14 tons bituminous coal.

DREDGING LOWER FOX RIVER.

Dredging the channel between De Pere and Green Bay having been suspended September 16, 1890, *Dredge No. 2* was towed to De Pere. Two new spuds were made, and on the 20th of the month the dredge and scows were towed to the river outlet of Kaukauna fifth lock, where 3,280 cubic yards of material were taken out of the channel, placed in dump scows, towed to deep water in the river and dumped. On the 30th of the month the dredge went to Kaukauna first level and worked there 3 days at removing stone and other obstructions from the canal and was then towed to the river outlet of the Combined Lock at Little Chute, where she worked until the 16th of October, removing large stone and cleaning coamings in the channel. The largest of the stones were banked at the side of the river and 490 cubic yards of small stone and gravel removed from the coamings were scowed to deep water and deposited.

Dredge No. 3 completed the second cut between the head of the canal and the lock at Menasha, removing 3,610 cubic yards of hard-pan and gravel, all of which were put in dump scows, towed to the left side of the rock-cut, and dumped. July 25, 1890, the dredge and scows were towed to Grignon Rapids, above the upper dam at Appleton. Loose rock and other obstructions were removed from the channel just above the Milwaukee and Northern Railway Bridge, and on the 28th of July the dredge went to the Menasha River and worked until August 1, taking out 265 cubic yards of gravel and stone. She was then towed to Appleton to assist in building a cofferdam across the canal above the fourth lock. The cofferdam was completed on the 7th of August, and from that time until the 16th of the month the dredge was employed in dredging the channel below Appleton third lock, removing therefrom a part of an old cofferdam and 1,305 cubic yards of stone and mud. The repairs of the fourth lock having been completed and the cofferdam removed, the dredge returned to Menasha River on the 20th of August and worked until the end of the month, taking out 1,600 cubic yards of stone and gravel, completing the work of cleaning the channel. The dredge and scows were towed to Neenah River August 31. On November 4 the plant was towed to the river outlet of Appleton fourth lock. The dredge removed 1,450 cubic yards of stone and gravel, which were put in dump scows, towed to deep water in the river, and dumped. The work of cleaning the channel was completed and dredging suspended for the season on November 13, 1890, and the dredge towed to Appleton first lock, to assist in building cofferdams above and below the lock.

There were purchased and expended—

For dredge No. 2, 34 cords of wood, 6 gallons lard oil, 2 gallons kerosene oil, and 2,411 feet B. M. oak lumber.

For dredge No. 3, 664 cords of wood, 32 pounds of steel, 35 pounds Norway iron, 300 pounds wrought iron, 266 pounds iron castings, 13 pounds hexagon nuts, 5 pounds nails, 10 gallons kerosene oil, and 310 pounds blacksmith coal.

For steam launch *General Meade*, 6 gallons lard oil, 3 gallons kerosene oil, and 3 tons of anthracite coal.

For steam tug *Dekorra*, 4 screen doors, 443 pounds steel, 6 pounds wrought iron, 8 pounds spikes, 14½ pounds assorted packing, and 41 tons bituminous coal.

DREDGING UPPER FOX RIVER.

Dredge No. 5 continued the work of making a 4-foot channel between Fort Winnebago and Governor Bend Locks. From a point about half a mile below the first-mentioned lock, a cut 14,471 feet in length, 60 feet in width, and an average depth of 2 feet was made, 65,358 cubic yards of sand were removed and banked at the side of the river. On the 3d of December, 1890, the dredging of the channel having been completed to within 1 mile of Governor Bend Lock, the dredge moved down to a bar just below the lock and took out 500 cubic yards of sand, which work having been finished on the 5th of December dredging for the season was suspended and the dredge laid up at Governor Bend Lock.

May 5, 1891, the repairs of the dredge having been completed, dredging was resumed at the bar below Governor Bend lock, where a cut 150 feet in length, 45 feet in width, and 1.5 feet in depth was made, from which 375 cubic yards of sand were removed and banked at the side of the river. The dredge then dropped down to a bar 900 feet below the lock and made one cut through the bar, removing and banking 488 cubic yards of material; from the next bar, a distance of 600 feet farther downstream, 314 cubic yards of sand were dredged and banked. The dredge was then towed by steamer *Boscobel* to a bar 500 feet below Montello Lock, where a cut 275 feet in length, 45 feet in width, and 2 feet in depth was made; 916 cubic yards of sand were taken out and banked at the side of the river. On the 10th of May the steamer *Boscobel* towed the dredge to a point one-fourth of a mile below Grand River Lock, and on the following day the work of dredging a 6-foot channel through the bar at that place was commenced. A cut 1,042 feet in length, 60 feet in width, and an average depth of about 4 feet, was made, from which 8,219 cubic yards of sand were removed and banked at the side of the river. The dredge then dropped down to Wilsons Bar and took out and banked 781 cubic yards of material.

Dredge No. 7 completed the dredging of a channel between Berlin Lock and Berlin early in July, and was employed the remainder of the season in the removal of bars between Berlin and Omro. From the channel between Berlin Lock and Berlin 1,357 cubic yards of sand and gravel were removed, of which 748 cubic yards were rehandled, and from the bars between Berlin and Omro there were removed and banked 58,839 cubic yards of clay and sand. In order to place the dredged material at a safe distance from the channel 22,905 cubic yards were rehandled. The total length of cut made was 20,092 feet. Dredging was suspended November 13 and the dredge towed to Eureka Lock and laid up for the season. The dredge was put in commission May 6, 1891, and employed until the 11th of the month in cleaning the

canal above Eureka Lock. Two thousand five hundred and thirty yards of sand and mud were taken out and placed on the canal banks.

There were purchased and expended as follows:

For Dredge No. 5, 48 feet B. M., maple lumber, 32 pounds steel, 38 pounds iron, 25 pounds assorted packing, 122½ feet iron pipe and fittings, 327 pounds rope, 161 pounds cotton waste, 74 gallons kerosene oil, 5 gallons boiled linseed oil, 26 gallons Eldorado castor oil, 8 gallons lard oil, 5 gallons cylinder oil, 51 gallons black oil, 10 pounds red paint, 2 clam poles, 1 grind stone, 1 barrel salt, 1 barrel lime, 100 pounds black-smith coal, and 170 cords of wood.

For Dredge No. 7, 62 feet, B. M., maple and 40 feet, B. M., pine lumber, 419 pounds steel, 364 pounds iron, 6 pounds screw bolts, 16 pounds nuts, 2,096 pounds iron castings, 251 pounds brass castings, 15 pounds lead, 8½ pounds zinc, 13½ pounds assorted packing, 16 feet iron pipe and fittings, 33 gallons kerosene oil, 51 gallons Eldorado castor oil, 12 boxes axle grease, 5 lights glass, and 338 cords of wood.

For Steamer Boscobel, 92 pounds steel, 10 pounds Babbitt metal, 4 pounds lead pipe, 25 pounds assorted packing, 22 feet iron pipe and fittings, 41 pounds rope, 2 pounds putty, 5 lights glass, 55 pounds cotton waste, 28 gallons kerosene oil, 2 gallons cylinder oil, 25 gallons Eldorado castor oil, 9 gallons lard oil, 1 globe valve, 18 cords of wood, and 76½ tons of bituminous coal.

Very respectfully, your obedient servant,

SAMUEL WHITNEY,
Assistant Engineer.

Maj. CHAS. E. L. B. DAVIS,
Corps of Engineers, U. S. A.

OPERATING AND CARE OF CANALS AND OTHER WORKS OF NAVIGATION APPLIED TO
FOX RIVER, WISCONSIN; SECTION 4 OF RIVER AND HARBOR ACT OF JULY 5, 1884.

Detailed statement of expenditures for fiscal year ending June 30, 1891, with itemized statement of expenses attached, as required by the above act of July 5, 1884.

Character of work, etc.	Item of expense.	Amount.	Total.
Repairs of De Pere Lock	Materials	\$402.10	
Do	Labor	289.68	
			\$691.78
Repairs of De Pere Dam	Labor	61.00	
			61.00
Repairs of Little Kaukauna Lock	Labor	9.25	
			9.25
Repairs of Little Kaukauna Dam	Materials	370.29	
Do	Labor	589.85	
			960.14
Repairs of Kaukauna Warehouse	Materials	82.29	
			82.29
Repairs of Rapid Croche Lock	Materials	969.91	
Do	Labor and transportation	2,474.12	
			3,444.03
Repairs of Rapid Croche Dam	Labor	737.87	
			737.87
Repairs of Kankauna Fourth Lock	Materials	262.00	
Do	Labor	1,001.30	
			1,263.30
Repairs of Kaukauna Third Lock	Labor	93.23	
			93.23
Repairs of Kaukauna Third Level	Materials	73.08	
Do	Labor	492.47	
			565.55
Repairs of Kaukauna Second Lock	Materials	52.76	
Do	Labor	797.30	
			850.06
Repairs of Kaukauna First Lock	Labor	61.58	
			61.58
Repairs of Kaukauna Dam	Labor	512.73	
			512.73
Repairs of Kaukauna Canal banks	Labor	531.47	
			531.47
Repairs of Little Chute Combined Locks	Labor	105.75	
			105.75
Repairs of Little Chute Second Lock	Labor	67.67	
			67.67
Repairs of Little Chute First Lock	Labor	42.74	
			42.74

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Detailed statement of expenditures for fiscal year ending June 30, 1891, etc.—Continued.

Character of work, etc.	Item of expense.	Amount.	Total.
Repairs of Cedars Lock	Labor	\$7. 21	
Repairs of Cedars Dam	Labor	671. 73	\$7. 21
Repairs of Appleton Fourth Lock	Materials	962. 67	671. 73
Do	Labor and transportation	1, 428. 09	
Repairs of Appleton Third Lock	Materials	19. 36	2, 391. 36
Do	Labor	133. 77	
Repairs of Appleton Second Lock	Materials	1. 80	153. 13
Repairs of Appleton First Lock	Materials	97. 59	1. 80
Do	Labor	313. 27	
Repairs of Waste Weir, Appleton Third Lock	Labor	20. 00	410. 86
Repairs of Appleton Upper Dam	Materials	805. 26	20. 00
Do	Labor	454. 71	
Repairs of Menasha Lock	Labor	1. 00	1, 259. 97
Repairs of Eureka Lock	Materials	1, 363. 82	1. 00
Do	Labor	1, 096. 05	
Repairs of Eureka Dam	Materials	134. 49	2, 459. 87
Do	Labor and transportation	805. 55	
Repairs of Eureka Lock House	Labor	20. 00	940. 04
Repairs of Berlin Lock House	Materials	1. 75	20. 00
Repairs of Montello Dam	Labor	78. 66	1. 75
Repairs of Portage Levee	Materials	22. 00	78. 66
Do	Labor	14. 75	
General repairs of locks and dams	Materials	1, 660. 46	36. 75
Do	Labor	1, 119. 06	
Dredging bars, Lower Fox	Fuel, supplies, etc.	309. 87	2, 779. 52
Do	Labor	2, 530. 28	
Dredging bars, Upper Fox	Fuel, supplies, etc.	2, 575. 31	2, 840. 13
Do	Labor	5, 307. 01	
Repairs of boats and dredges	Rent of boat-yard at Oshkosh	75. 00	7, 882. 39
Do	Repairs of scow	125. 62	
Do	Repairs of barge	19. 66	
Do	Repairs of Dredge No. 2	10, 862. 68	
Do	Repairs of Dredge No. 4	13, 091. 47	
Do	Repairs of Dredge No. 7	212. 85	
Maintenance of navigation	Locktenders' services	6, 891. 32	24, 987. 28
Do	Gaugekeepers' services	140. 00	
Do	Labor and transportation	198. 12	
Do	Rope for lock lines	46. 26	
Care of works and property	Watchmen, labor and transportation	1, 217. 13	7, 275. 70
Do	Traveling expenses of assistant engineers, overseers, etc.	171. 27	
Do	Rent of storehouse, Appleton	135. 00	
Do	Telephone service	15. 35	
Contingencies	Salaries of assistant engineers, clerks, etc.	2, 839. 99	1, 538. 75
Do	Rent of office at Appleton	75. 00	
Do	Rent of office at Oshkosh	66. 00	
Do	Rent of office at Milwaukee	70. 00	
Do	Stationery	59. 34	
Do	Mileage of officers	40. 40	
Total			3, 150. 73
			68, 989. 00

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, applied to Fox River, Wisconsin.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1890.				
July 26	1	F. C. Hanford	Oil.	\$34.66
26	2	John James	Services	26.00
26	3	Conlee Lumber Company	Lumber	58.32
26	4	Chas. T. Strond	Oakum, etc	38.02
26	5	K. M. Hutchinson	Iron, etc	15.00
26	6	Jas. Gillingham & Son	Screwbolts, etc.	10.93
26	7	A. F. Mueller	Hire of Jackscrews	7.75
26	8	L. E. Chapelle	Paint, etc	29.00
31	9	Paul E. Thomas	Services	50.00
31	10	C. A. Fuller	do	200.00
31	11	Andrew O'Connell	do	10.00
31	12	John M. Paige	do	35.00
31	13	John A. Banker	do	30.00
31	14	Alexander Sims	do	30.00
31	15	James Clear	do	35.00
31	16	John Baeten	do	30.00
31	17	Jerry Parkinson	do	30.00
31	18	Gottlieb Jahnke	do	30.00
31	19	John Lewis	do	30.00
31	20	George Gifford	do	30.00
31	21	Richard E. Rice	do	30.00
31	22	Gabriel Wick	do	30.00
31	23	Samuel Whitney	do	155.00
31	24	Thomas Meyers	do	31.00
31	25	Des Forges & Company	Stationery	16.20
31	26	Charles W. Day	Lumber	35.02
31	27	Luther Lindauer	Coal, etc	11.00
31	28	Jno. Jansen	Lumber	16.33
31	29	Rutler Brothers	Tin roofing, etc	82.28
31	30	Gerry Lumber Company	Lumber	12.28
31	31	Alfred Galpins' Sons	Nails, etc	15.84
31	32	J. F. Joslyn	Labor	1.00
31	33	J. J. Marshall	Oil, etc.	2.00
31	34	J. C. Koelsch	Packing, etc	4.77
31	35	Robinson & Riley	Coal	9.04
31	36	D. T. H. MacKinnon	Steel, etc.	13.00
31	37	James Gillingham & Son	Lumber	1.68
31	38	A. Sanford Logging Tool Company	Pike poles	10.80
31	39	McKenzie & Crawford	Coal	108.27
31	40	H. S. Sacket	Packing, etc	14.47
31	41	Niels Johnson	Babbet metal, etc	26.02
31	42	Charles S. Morris	Coal, etc	91.75
31	43	Priest & Garrow	Wood	339.50
31	44	Warner Hardware Company	Oil, etc	2.87
31	45	C. A. Fuller	Traveling expenses	10.42
31	46	Joya, Norris & Co	Rope, etc	55.15
31	47	Milwaukee Sewer Pipe Company	Cement	24.06
Aug. 4	1	Samuel Whitney	Traveling expenses	9.17
4	2	Charles M. Cole	do	4.90
4	3	Hired men	Services, July, 1890	3,094.95
5	4	Ramey & Jones	Lumber	108.25
7	5	Atlas Iron and Brass Works	Piston rings	4.50
7	6	Patrick Coyle	Services	3.80
11	7	Frank Lappens	do	4.50
11	8	Maj. Charles E. L. B. Davis	Mileage	18.00
12	9	George Furance	Services	9.18
15	10	Ike Johnson	do	15.00
20	11	Hired men	do	773.58
22	12	C. A. Fuller	Traveling expenses	9.85
22	13	Orville Beach	Rent of land	25.00
28	14	Frederick Schneider	Services	7.81
31	15	A. Ross Houston	do	200.00
31	16	C. A. Fuller	do	200.00
31	17	Andrew O'Connell	do	10.00
31	18	John M. Paige	do	35.00
31	19	John A. Banker	do	30.00
31	20	Alexander Sims	do	30.00
31	21	James Clear	do	35.00
31	22	John Baeten	do	30.00
31	23	Jerry Parkinson	do	30.00
31	24	Gottlieb Jahnke	do	30.00
31	25	John Lewis	do	30.00
31	26	George Gifford	do	30.00
31	27	Richard E. Rice	do	30.00
31	28	Hired men	do	50.90
31	29	Gabriel Wick	do	30.00
31	30	Charles M. Cole	Traveling expenses	20.01
31	31	C. A. Fuller	do	6.47
31	32	Schlafer, Barrett & Tesch	Wheelbarrows, etc.	54.18

2590 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Itemized statement of expenses, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1890,				
Aug. 31	33	Gerry Lumber Company.....	Lumber.....	\$80.08
31	34	Ramsay & Jones.....	do.....	80.84
31	35	Appleton Machine Company.....	Iron castings, etc.....	277.48
31	36	J. C. Koelsch.....	Screen doors, etc.....	16.60
31	37	D. T. H. MacKinnon.....	Steel, etc.....	6.25
31	38	Wm. Schubert.....	Hauling stone.....	139.08
31	39	Wm. Krueger & Co.....	Iron.....	1.75
31	40	Conlee Lumber Company.....	Lumber.....	15.48
31	41	McKenzie & Crawford.....	Wood, etc.....	290.02
31	42	Chas. S. Morris.....	Coal.....	96.75
31	43	Niels Johnson.....	Iron castings, etc.....	109.85
31	44	Priest & Garrow.....	Wood.....	274.77
31	45	J. E. Wells & Co.....	Cotton waste, etc.....	15.92
31	46	J. H. Daly.....	Pipe and fittings.....	3.69
31	47	H. S. Sackett.....	Steel, etc.....	25.36
31	48	Des Forges & Co.....	Stationery.....	22.10
31	49	Drake Brothers.....	Oil, etc.....	13.25
31	50	Milwaukee Sewer Pipe Company.....	Cement.....	20.70
Sept. 3	1	Samuel Whitney.....	Services.....	55.00
3	2	Thomas Myers.....	do.....	31.90
3	3	Samuel Whitney.....	Traveling expenses.....	14.61
4	4	James Roche.....	Hickory poles.....	16.00
4	5	Hired men.....	Services, August, 1890.....	3,137.38
9	6	G. W. Jenkins.....	Services.....	5.00
9	7	Weber Bros.....	Sheets, etc.....	12.84
10	8	Harry Stroehle.....	Services.....	7.50
13	9	Vulcan Iron Works.....	Dipper teeth, etc.....	118.00
27	10	Henry Thomas.....	Depositing dredged material.....	5.46
27	11	Charles Young.....	do.....	8.30
27	12	G. Ehrlich.....	do.....	8.45
27	13	D. W. Orton.....	do.....	9.11
27	14	H. B. Livermore.....	do.....	9.72
27	15	Theodore Gloeckler.....	do.....	14.33
27	16	Patrick Lehane.....	do.....	58.72
30	17	C. A. Fuller.....	Services.....	200.00
30	18	Andrew O'Connell.....	do.....	10.00
30	19	John M. Paige.....	do.....	35.00
30	20	John A. Banker.....	do.....	30.00
30	21	Alexander Sims.....	do.....	30.00
30	22	James Clear.....	do.....	35.00
30	23	John Beaton.....	do.....	30.00
30	24	Jerry Parkinson.....	do.....	30.00
30	25	Gottlieb Jahnke.....	do.....	30.00
30	26	John Lewis.....	do.....	30.00
30	27	George Gifford.....	do.....	30.00
30	28	Richard E. Rice.....	do.....	30.00
30	29	Gabriel Wick.....	do.....	30.00
30	30	Charles W. Day.....	Lumber.....	238.00
30	31	John Schlosser.....	Damper, etc.....	2.70
30	32	Alfred Galpin's Sons.....	Stoves, etc.....	12.35
30	33	Schlafer, Barrett & Tesch.....	Boat spikes, etc.....	18.75
30	34	B. T. Gilmore.....	Office rent.....	25.00
30	35	A. L. Smith.....	Hire of house.....	45.00
30	36	Appleton Machine Company.....	Lock valves.....	138.00
30	37	Doman & Manuel.....	Brass castings, etc.....	28.98
30	38	McKenzie & Crawford.....	Coal, etc.....	70.71
30	39	H. S. Sackett.....	Oil, etc.....	8.17
30	40	Niels Johnson.....	Steel, etc.....	40.05
30	41	Priest & Garrow.....	Wood.....	213.87
30	42	J. E. Wells & Co.....	Soap, etc.....	4.40
30	43	Drake Brothers.....	Oil.....	6.63
Oct. 2	1	C. A. Fuller.....	Traveling expenses.....	11.76
2	2	Milwaukee Cement Company.....	Cement.....	30.12
2	3	H. Collette.....	Towing.....	32.00
2	4	Charles M. Cole.....	Traveling expenses.....	3.36
6	5	Hired men.....	Services, September, 1890.....	2,942.55
6	6	Roy Sims.....	Services.....	21.00
8	7	James Jones.....	do.....	18.00
9	8	John McCormick.....	do.....	18.00
9	9	Matthew Sinnott.....	Depositing dredged material.....	86.70
12	10	Theodorus Wissink.....	Services.....	8.12
13	11	Henry Weyentling.....	do.....	16.50
22	12	Hired men.....	do.....	342.24
31	13	James McDaniel.....	Wood.....	2.35
31	14	M. F. Barteau.....	Hay.....	7.42
31	15	H. A. Foster.....	Oil.....	9.00
31	16	Gerry Lumber Company.....	Lumber.....	165.80
31	17	Ramsay & Jones.....	do.....	357.04
31	18	Appleton Machine Company.....	Iron castings, etc.....	734.77
31	19	Howard & Jennings.....	Globe valves, etc.....	1.78
31	20	Doman & Manuel.....	Brass castings, etc.....	20.77

Itemized statement of expenses, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1890.				
Oct. 31	21	Conlee Lumber Company.	Lumber.	\$250.84
31	22	J. A. Barnes.	Steel, etc.	312.52
31	23	Niels Johnson.	Oil, etc.	21.25
31	24	H. S. Sacket.	Rope, etc.	22.25
31	25	Charles S. Morris.	Coal.	118.50
31	26	Priest & Garrow.	Wood.	224.75
31	27	Oliver Dempsey.	Depositing dredged material.	18.21
31	28	McKenzie & Crawford.	Wood, etc.	154.10
31	29	C. A. Fuller.	Services.	200.00
31	30	Andrew O'Connell.	do.	10.00
31	31	John M. Paige.	do.	35.00
31	32	John A. Banker.	do.	30.00
31	33	Alexander Sims.	do.	30.00
31	34	John Baeten.	do.	30.00
31	35	George Gifford.	do.	30.00
31	36	Gabriel Wick.	do.	30.00
31	37	Gottlieb Jahnke.	do.	30.00
31	38	Jerry Parkinson.	do.	30.00
31	39	John Lewis.	do.	30.00
31	40	Richard E. Rice.	do.	30.00
31	41	James Clear.	do.	35.00
Nov. 4	42	Samuel Whitney.	Traveling expenses.	13.75
6	43	Hired men.	Services October, 1890.	3, 123.26
8	44	George S. Bartlett.	Cement.	43.88
8	45	James Mackin.	Services.	24.75
8	46	John Thalhofer.	do.	6.66
12	47	Chicago, Milwaukee and St. Paul Railway Company.	Valve, etc.	9.53
15	48	J. L. Evans.	Services.	60.00
15	49	Orville Beach.	Rent of land.	25.00
15	50	Ryan Brothers.	Hauling out dredge.	200.00
15	51	Priest & Garrow.	Oak piles, etc.	1, 165.03
18	52	Hatch & Keith.	Timber.	343.91
19	53	Hired men.	Services.	144.48
21	54	do.	do.	414.40
29	55	Eugene Smith & Co.	Coal.	6.50
29	56	William Moulemans.	Elm logs.	27.00
29	57	Ramsay & Jones.	Lumber.	3.06
29	58	Schlafer, Barrett & Tesch.	Spikes, etc.	10.44
29	59	John Schlosser.	Coal stove, etc.	43.55
29	60	Appleton Machine Company.	Iron rods, etc.	526.72
29	61	Doman & Manuel.	Iron, etc.	4.04
29	62	K. M. Hutchinson.	Cast steel, etc.	8.53
29	63	Conlee Lumber Company.	Lumber.	10.00
29	64	McKenzie & Crawford.	Coal.	41.66
29	65	H. S. Sacket.	Oil, etc.	8.10
29	66	Niels Johnson.	Steel castings, etc.	30.54
29	67	John W. Slater.	Oil, etc.	47.67
29	68	Charles S. Morris.	Coal.	51.75
29	69	Priest & Garrow.	Wood.	66.70
29	70	J. H. Daly.	Iron, pipe, etc.	22.36
29	71	John J. Johnson.	Wood.	40.80
30	72	C. A. Fuller.	Services.	200.00
30	73	Andrew O'Connell.	do.	10.00
30	74	George T. Allanson.	do.	30.00
30	75	John M. Paige.	do.	30.00
30	76	John Baeten.	do.	25.00
30	77	George Gifford.	do.	25.00
30	78	Gabriel Wick.	do.	25.00
30	79	Gottlieb Jahnke.	do.	25.00
30	80	Jerry Parkinson.	do.	25.00
30	81	John Lewis.	do.	25.00
30	82	Richard E. Rice.	do.	25.00
30	83	James Clear.	do.	30.00
30	84	John A. Banker.	do.	25.00
30	85	Alexander Sims.	do.	25.00
Dec. 2	86	E. O. Hoffman.	Traveling expenses.	2.92
4	87	Hired men.	Services, November, 1890.	2, 093.30
8	88	John McCormack.	Services.	3.00
8	89	August Thiele.	do.	10.50
13	90	Hired men.	do.	88.50
18	91	C. A. Fuller.	do.	100.66
19	92	A. Ross Houston.	Traveling expenses.	11.40
22	93	Excelsior Iron Works.	Iron mast, etc.	3, 240.00
24	94	E. D. Haven.	Paper.	1.88
29	95	Rather & Schaeuble.	Iron, etc.	17.07
29	96	Ruel Bros.	Wood.	25.00
29	97	Schlafer, Barrett & Tesch.	Belting.	4.80
29	98	Gerry Lumber Co.	Lumber.	14.30
29	99	F. H. Blood.	Coal, etc.	17.00
29	100	B. T. Gilmore.	Rent of office.	25.00

2592 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Itemized statement of expenses, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1890.				
Dec. 29	101	A. L. Smith	Hire of house	\$45.00
29	102	Appleton Machine Co	Iron, etc.	72.80
29	103	A. Sanford Logging Tool Co	Heavy handles, etc.	6.50
29	104	K. M. Hutchinson	Stove pipe, etc.	10.25
29	105	J. E. Wells & Co	Oil, etc.	6.87
29	106	John Cushing	Depositing dredged material	59.10
29	107	E. B. Maltbey	Wood	87.00
30	108	Des Forges & Co	Stationery	21.05
31	109	Wisconsin Telephone Co	Rent of telephone, etc.	15.35
31	110	Samuel Whitney	Services	73.33
31	111	George T. Allanson	do	30.00
31	112	John M. Paige	do	30.00
31	113	John A. Banker	do	35.00
31	114	Alexander Sims	do	35.00
31	115	John Baeten	do	25.00
31	116	George Gifford	do	25.00
31	117	Gabriel Wick	do	25.00
31	118	Gottlieb Jahnke	do	25.00
31	119	Jerry Parkinson	do	25.00
31	120	John Lewis	do	25.00
31	121	Richard E. Rice	do	25.00
31	122	James Clear	do	30.00
1891.				
Jan. 2	1	Elwin Banter	Traveling expenses	3.87
2	2	Samuel Whitney	do	20.14
5	3	Hired men	Services, December, 1890	1,773.50
5	4	John James	Services	11.66
6	5	William Fergusson	do	9.62
6	6	William Egan	do	38.25
16	7	Hired men	do	13.50
22	8	Maj. Charles E. L. B. Davis	Mileage	24.40
28	9	Hired men	Services	375.23
31	10	Samuel Whitney	do	200.00
31	11	George T. Allanson	do	30.00
31	12	John M. Paige	do	30.00
31	13	John A. Banker	do	35.00
31	14	Alexander Sims	do	35.00
31	15	John Baeten	do	25.00
31	16	George Gifford	do	25.00
31	17	Gabriel Wick	do	25.00
31	18	Gottlieb Jahnke	do	25.00
31	19	Jerry Parkinson	do	25.00
31	20	John Lewis	do	25.00
31	21	Richard E. Rice	do	25.00
31	22	James Clear	do	30.00
31	23	Hans Jacobson	Tamarack knees	318.00
31	24	Ruel Bros	Wood	25.00
31	25	S. S. Clark	Clay	27.20
31	26	Alfred Galpin's Sons	Boat spikes	25.00
31	27	Appleton Machine Co	Iron rods, etc.	49.47
31	28	Ramsay & Jones	Lumber	292.00
31	29	The Cook & Brown Lume Co.	Coal	6.00
31	30	K. M. Hutchinson	Iron, etc.	36.39
31	31	S. M. Hay & Bros	do	268.09
31	32	Hugh McGowan	Labor	5.25
31	33	Glenwood Manufacturing Co.	Lumber	1,194.74
Feb. 2	34	Western Lime and Cement Co	Cement	26.60
2	35	William Wick	Labor, etc.	52.50
3	36	Elwin Banter	Traveling expenses	3.17
4	37	Hired men	Services, January, 1891	1,821.76
4	38	Osgood Dredge Co	Freight charges	159.93
5	39	Melkielejohn & Hatten	Lumber	1,861.58
9	40	Orville Beach	Rent of land	25.00
16	41	Swain & Tate	Reports, etc.	12.50
20	42	Theodore Dasher	Services	3.75
26	43	Charles H. Welch	Paper, etc.	17.65
26	44	Hired men	Services	211.22
28	45	Samuel Whitney	do	200.00
28	46	George T. Allanson	do	30.00
28	47	John M. Paige	do	30.00
28	48	John A. Banker	do	35.00
28	49	Alexander Sims	do	35.00
28	50	John Baeten	do	25.00
28	51	George Gifford	do	25.00
28	52	Gabriel Wick	do	25.00
28	53	Gottlieb Jahnke	do	25.00
28	54	Jerry Parkinson	do	25.00
28	55	John Lewis	do	25.00
28	56	Richard E. Rice	do	25.00
28	57	James Clear	do	30.00

Itemized statement of expenses, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1891.				
Feb. 28	58	Cornelius Huisenfeldt	Driving piles	\$87.75
28	59	Charles Cavert	Sand	20.48
28	60	Appleton Machine Co.	Iron bolts, etc.	60.73
28	61	Gorry Lumber Co.	Lumber	186.78
28	62	Schlafer, Barrett & Tesch	Iron, etc.	255.28
28	63	Ramsay & Jones	Lumber	562.54
28	64	K. M. Hutchinson	Iron, etc.	7.88
28	65	The Morgan Co.	Driving plank	14.00
28	66	George F. Stroud estate	Oakum	61.50
28	67	Gillingham & Son	Iron truss rods, etc.	338.22
Mar. 2	68	A. H. Gardner Co.	Powder, etc.	65.79
2	69	Drake Brothers	White lead, etc.	145.48
3	70	Glenwood Manufacturing Co.	Lumber	961.68
3	71	Charles M. Cole	Traveling expenses	7.36
3	72	Western Lime & Cement Co.	Cement	120.00
4	73	Hired men	Services, February 1891	2,757.27
5	74	Elwin Banter	Traveling expenses	2.62
10	75	Martin Olesen	do	3.25
10	76	Charles A. Thompson	do	18.81
11	77	Glenwood Manufacturing Co.	Lumber	755.63
16	78	Frank L. Blood	Services	21.33
17	79	Hired men	do	123.75
30	80	John Jensen	Lumber	3.44
30	81	Butler Bros.	Safety fuse, etc.	9.53
30	82	B. T. Gilmore	Rent of office	25.00
30	83	A. L. Smith	Hire of house	45.00
30	84	Gillingham & Son	Screw bolts, etc.	10.28
30	85	K. M. Hutchinson	Iron, etc.	22.38
30	86	The Morgan Co.	Lumber, etc.	221.45
31	87	George T. Allanson	Services	80.00
31	88	John M. Faige	do	30.00
31	89	John A. Banker	do	35.00
31	90	Alexander Sims	do	35.00
31	91	John Baeten	do	25.00
31	92	George Gifford	do	25.00
31	93	Gabriel Wick	do	25.00
31	94	Gottlieb Jahnke	do	25.00
31	95	Jerry Parkinson	do	25.00
31	96	John Lewis	do	25.00
31	97	Richard E. Rice	do	25.00
31	98	James Clear	do	30.00
April 1	1	Sylvanus Palmer	do	60.00
1	2	Samuel Whitney	do	200.00
1	3	Western Lime and Cement Co.	Cement	118.75
2	4	George F. Stroud estate	Oakum, etc.	38.40
3	5	Charles M. Cole	Traveling expenses	14.28
4	6	Hired men	Services, March, 1891	2,720.09
6	7	John Kilawee	Services	30.00
11	8	Joseph Bleier	do	37.50
11	9	Martin Olesen	do	30.75
11	10	Hired men	do	102.00
17	11	Bardick, Armitage & Allen	Rules for navigation	4.50
20	12	Rael Bros.	Wood	12.50
20	13	L. Lindauer	Cement, etc.	73.78
20	14	Appleton Machine Co.	Iron rods, etc.	17.56
20	15	Redford Bros. & Co.	Surfacing lumber	2.00
20	16	A. F. Mneller	Hire of jackscrews	7.50
20	17	The Cook and Brown Lime Co.	Coal, etc.	8.85
20	18	Conlee Lumber Co.	Lumber	25.06
20	19	McKenzie & Crawford	Coal, etc.	30.81
20	20	Battis Bros.	Iron, etc.	34.68
20	21	George F. Stroud estate	Oakum, etc.	60.15
20	22	K. M. Hutchinson	Iron, etc.	126.18
20	23	Gillingham & Son	Screw bolts, etc.	223.23
20	24	J. A. Barnes	Iron castings, etc.	802.00
20	25	George Service	Services	37.75
30	26	Paul E. Thomas	do	65.00
30	27	Samuel Whitney	do	200.00
30	28	James Clear	do	30.00
30	29	John Lewis	do	25.00
30	30	John M. Page	do	30.00
30	31	John A. Banker	do	31.66
30	32	George Gifford	do	25.00
30	33	Gottlieb Jahnke	do	25.00
30	34	Alexander Sims	do	29.66
30	35	George T. Allanson	do	30.00
30	36	Jerry Parkinson	do	25.00
30	37	Gabriel Wick	do	25.00
30	38	John Baeten	do	25.00
30	39	Richard E. Rice	do	25.00
May 2	40	Hired men	Services, April, 1891	2,433.47

2594 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Itemized statement of expenses, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1891.				
May 4	41	Charles M. Cole.....	Traveling expenses.....	\$12.34
7	42	Hired men.....	Services, April, 1891.....	41.23
11	43	Orville Beach.....	Rent of land.....	25.00
11	44	W. H. Crawford.....	Pipe and fittings, etc.....	78.95
11	45	Doman & Manuel.....	Castings, etc.....	240.86
11	46	Excelsior Iron Works.....	Mast, etc.....	1,732.20
31	47	Thos. Jackson.....	Screw bolts, etc.....	8.11
31	48	H. Collette.....	Lumber.....	12.90
31	49	Jno. Jansen.....	do.....	4.29
31	50	Gerry Lumber Company.....	do.....	14.40
31	51	Appleton Machine Company.....	Iron castings, etc.....	125.19
31	52	M. V. Morehouse.....	Boiler covering.....	43.06
31	53	A. Sanford Manufacturing Company.....	Steel.....	4.00
31	54	August Schroeder.....	Hire of jackscrews.....	5.25
31	55	Harnish & Westphal.....	Salt.....	5.75
31	56	Conlee Lumber Company.....	Lumber.....	15.73
31	57	D. P. Sanford.....	Oil.....	19.42
31	58	Geo. F. Stroud estate.....	Oakum, etc.....	54.88
31	59	Gillingham & Son.....	Screw bolts, etc.....	81.76
31	60	K. M. Hutchinson.....	Tin roofing, etc.....	221.49
31	61	The Morgan Company.....	Lumber.....	377.79
31	62	W. J. McLaughlin.....	Iron, etc.....	2.27
31	63	Niles Johnson.....	Packing, etc.....	7.80
31	64	C. A. Peck.....	Steel, etc.....	32.77
31	65	Chas. S. Morris.....	Coal.....	51.25
31	66	Priest & Garrow.....	Wood.....	124.70
31	67	Prentice & Mohr.....	Lumber.....	22.00
31	68	Joy's Bros. & Co.....	Cotton waste.....	10.54
31	69	O. L. Packard Machinery Company.....	Tool steel.....	25.30
31	70	A. Ross Houston.....	Services.....	200.00
31	71	Samuel Whitney.....	do.....	200.00
31	72	John M. Paige.....	do.....	30.00
31	73	Gabriel Wick.....	do.....	25.00
31	74	Alexander Sims.....	do.....	25.00
31	75	George T. Allanson.....	do.....	30.00
31	76	John Baeten.....	do.....	25.00
31	77	James Clear.....	do.....	30.00
31	78	Jerry Parkinson.....	do.....	25.00
31	79	John A. Banker.....	do.....	25.00
31	80	John Lewis.....	do.....	25.00
31	81	George Gifford.....	do.....	25.00
31	82	Gottlieb Jahneke.....	do.....	25.00
31	83	Richard E. Rice.....	do.....	25.00
31	84	C. L. Neumann.....	do.....	10.00
June 3	85	Samuel Whitney.....	Traveling expenses.....	9.90
5	86	Hired men.....	Services, May, 1891.....	2,024.51
8	87	John J. Johnson.....	Depositing dredged material.....	2.00
30	88	Conlee Lumber Company.....	Lumber.....	22.33
30	89	The Morgan Company.....	Doors, etc.....	32.78
30	90	Doman & Manuel.....	Iron castings, etc.....	44.99
30	91	Ossian Cook.....	Rent of office.....	66.00
30	92	Battis Brothers.....	Boiler flues, etc.....	214.72
30	93	Gillingham & Son.....	Screw bolts, etc.....	62.01
30	94	George F. Stroud estate.....	Oil, etc.....	14.40
30	95	A. Sanford Logging Tool Company.....	Lumber.....	2.00
30	96	The Cook and Brown Lime Company.....	Fire brick, etc.....	4.70
30	97	K. M. Hutchinson.....	Tin roofing, etc.....	308.47
30	98	J. A. Barnes.....	Iron castings, etc.....	821.63
30	99	Charles S. Morris.....	Coal.....	66.75
30	100	C. A. Peck.....	Lumber, etc.....	25.12
30	101	H. Stedman.....	Lumber.....	16.47
30	102	Stephen Vedder.....	Depositing dredged material.....	28.78
30	103	Cramer, Aikens & Cramer.....	Office rent.....	70.00
30	104	James Clear.....	Services.....	30.00
30	105	John M. Paige.....	do.....	30.00
30	106	John Lewis.....	do.....	25.00
30	107	Jerry Parkinson.....	do.....	25.00
30	108	George Gifford.....	do.....	25.00
30	109	Alexander Sims.....	do.....	25.00
30	110	John Baeten.....	do.....	25.00
30	111	George T. Allanson.....	do.....	30.00
30	112	John A. Banker.....	do.....	25.00
30	113	Gabriel Wick.....	do.....	25.00
30	114	Richard E. Rice.....	do.....	25.00
30	115	Gottlieb Jahneke.....	do.....	25.00
30	116	Joy's Bros. & Co.....	Rope.....	31.63
30	117	Samuel Whitney.....	Services.....	200.00
30	118	C. L. Neumann.....	do.....	10.00
30	119	Hired men.....	Services, June, 1891.....	2,234.39
30	120	Hollis Stedman.....	Moving stone.....	51.00
30	121	Samuel Whitney.....	Traveling expenses.....	10.51
		Total.....		68,989.00

APPENDIX M M.

IMPROVEMENT OF CHICAGO AND CALUMET HARBORS, ILLINOIS; OF CALUMET RIVER, ILLINOIS AND INDIANA; AND OF ILLINOIS RIVER, ILLINOIS; ILLINOIS AND MISSISSIPPI CANAL.

REPORT OF CAPTAIN W. L. MARSHALL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

- | | |
|---|---|
| 1. Chicago Harbor, Illinois. | 5. Operating and care of La Grange Lock, on Illinois River, Illinois. |
| 2. Calumet Harbor, Illinois. | 6. Illinois and Mississippi Canal. |
| 3. Calumet River, Illinois and Indiana. | |
| 4. Illinois River, Illinois. | |

EXAMINATION AND SURVEY.

7. Illinois River, Illinois, from La Salle to the Mississippi River, as recommended by Capt. W. L. Marshall; Corps of Engineers, in his report dated March 10, 1890, with a view to ascertaining what lands would be subject to overflow by the construction of a navigable waterway between Lake Michigan and the Mississippi River.

HARBOR LINES.

8. Establishment of harbor lines in Chicago Harbor, Illinois.
-

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., July 10, 1891.

GENERAL: I have the honor to transmit herewith annual reports upon the works in my charge for the fiscal year ending June 30, 1891.

* * * * *

Very respectfully, your obedient servant,

W. L. MARSHALL,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

M M I.

IMPROVEMENT OF CHICAGO HARBOR, ILLINOIS.

The present project was adopted in 1870 and modified in 1878, and contemplates—

(a) The formation of an outer harbor or basin by inclosing a portion of Lake Michigan just south of and adjoining the entrance to the river, for the purpose of increasing the harbor facilities of Chicago, and to give relief to the overcrowded river.

(b) The construction of an exterior breakwater of crib work filled with stone outside the outer harbor and north of the entrance to Chicago River, in deep water, to shelter the entrance to Chicago River (which constitutes the harbor of Chicago), and to the outer harbor from northerly storms, and to form a sheltered area or harbor of refuge at the southern end of Lake Michigan.

In addition to this project the entrance to Chicago River, which is protected by piers built by the United States, is to be maintained, both piers and channel.

CONDITION OF THE WORK JUNE 30, 1891.

Outer basin.—This basin, lying south and east of the present mouth of Chicago River, covers about 455 acres in area. A dock and wharf line was established by Special Order, Corps of Engineers, No. 108, August 3, 1871, at about 1,300 feet east of the shore line and parallel to and about 2,000 feet west of the breakwater that limits the basin to the eastward. This dock line extended from the mouth of Chicago River, south pier, to a point opposite Van Buren street. On September 15, 1890, a Board of Engineers was constituted by Special Order, No. 61, Headquarters Corps of Engineers, Washington, D. C., September 11, 1890, to consider the question of harbor lines under the river and harbor act of August 11, 1888, and in accordance with the recommendations of this Board, approved by the Secretary of War September 22, 1890,* the existing harbor line was extended throughout the harbor southward to its southern limit.

Between the dock line and breakwater an area of 270 acres is included, which the original project contemplated dredging to 16 feet in depth where deficient. The area between dock line and shore is reserved for slips and docks. Two hundred and sixty-seven thousand cubic yards of material are yet to be dredged from the outer basin beyond the dock line, but as the area already dredged is sufficient for present needs, and the material is necessary for the construction of any docks and wharves in this basin, no further dredging is desirable until such use becomes apparent.

The piers inclosing this basin have been completed for years, and now the only expenditures required are for maintenance.

The purposes of this outer harbor have never been realized, due to the litigation attending the determination of the question of riparian ownership and rights. No wharves and docks have been constructed, except by the Illinois Central Railroad, north of Randolph street, and the breakwaters serve only the purpose of protecting this corporate property, and affording to the people of Chicago a protected and safe basin for pleasure craft. Since the construction of the exterior breakwater it has no value as a harbor of refuge.

This basin will probably never subserve its intended purpose, and all

* See Appendix M M 8.

expenditures for maintaining the breakwaters and piers should be reduced to a minimum and be carefully considered. At most, temporary work of timber and rubblestone should be employed until its final disposition is determined.

During the past fiscal year it has been in question to use, by filling in, part of this basin as a site for part of the World's Columbian Exposition, finally for a park for the people of Chicago, forever. This use as far as the exposition is concerned is abandoned. Its use otherwise will probably depend upon the decision in the pending case before the United States Supreme Court upon the question of ownership of riparian rights and submerged lands. The logic of the present tendency of uses of Chicago property points to the conclusion that this outer basin will never be used for wharves and docks, or public commercial purposes. It may be filled as a park, or preserved as a pleasure basin; otherwise it may fall into the hands of a corporation.

The superstructure over all of the piers of the outer harbor at the beginning of the fiscal year was in more or less rotten condition, and in view of the preceding facts, although a permanent superstructure had been designed for them, it was judged best still further to temporize. Consequently, soon after the passage of the river and harbor act of September 19, 1890, it was recommended to the Chief of Engineers that the superstructure of this pier, from the light-house at the southerly entrance around the return to the north entrance to the basin, as well as the north pier, 1,000 feet in length, or in all, including the north pier, 5,243 feet in length, be rebuilt of timber crib work filled with stone, under the belief that by the end of the life of this construction all legal questions will have been disposed of and the future use of this basin and public works connected therewith will have been determined.

The project was approved and the work advertised, and proposals opened December 13, 1890, an abstract of which proposals as received is appended.

With the approval of the Chief of Engineers, contract was entered into January 5, 1891, with the Kimbell & Cobb Stone Company of Chicago, the lowest responsible bidders, for the rebuilding of 5,243 feet of superstructure, with pile protection, and repairs of superstructure, of easterly breakwater, outer basin, and north pier entrance to Chicago River, in accordance with the terms of their bid.

Work under the contract was begun May 9, 1891, on the easterly breakwater, and very vigorously prosecuted by the contractors, and by the close of the fiscal year, June 30, 1891, they had placed and framed into the work 749,240 feet B. M., of pine timber, and 70,573 pounds of wrought iron driftbolts. In addition a portion of the decking has been placed but not yet measured or estimated. At the close of the year about 1,700 linear feet of the timber superstructure over the easterly breakwater have been completed except decking and stone filling.

Exterior breakwater.—The work is situated one mile northeast of the mouth of Chicago River, the entrance to which it covers from northerly storms. It is 5,413 feet in length, and is completed.

During the past fiscal year a portion of this breakwater has been decked over to protect the stone filling from washouts by storms, by securing in place, over the superstructure and stone filling, about 973,572 feet B. M. timber, by means of 71,471 pounds of wrought iron driftbolts, of which all of the timber and 65,087 pounds of the driftbolts was material on hand at the beginning of the fiscal year.

Part of this breakwater had previously been decked over with three inch plank, but the greater part of it had been open to the fury of Lake

Michigan storms. The 3-inch decking was smashed in and the stone washed out by the waves. Now two-thirds of the breakwater is covered by a decking at least 10 inches thick, which will much reduce the annual cost of maintenance during the life of the superstructure.

This breakwater answers the purpose for which it has been constructed, and its value, as forming a safe harbor of refuge during northerly storms and as an aid to navigation using the port of Chicago, is conceded by all parties interested in lake commerce.

ENTRANCE TO CHICAGO RIVER.

No work has been done during the past fiscal year, there being throughout the year no difficulty experienced by vessels due an insufficient depth of channel. The entrance will require periodic dredging. The last dredging done was in October and November, 1888.

Under the contract hereinbefore mentioned with Kimbell and Cobb Stone Company, Chicago, the rebuilding superstructure over the north pier 1,000 feet in length, and the repairs due injury by collisions with vessels, have been provided for under the appropriation contained in the river and harbor act of September 19, 1890.

PROPOSED APPLICATION OF FUNDS NOW ON HAND AND THOSE ASKED FOR, FOR THE FISCAL YEAR ENDING JUNE 30, 1892.

The funds now on hand and those asked for, for the fiscal year ending June 30, 1892, are to be applied to the completion of the work under the existing contract for rebuilding superstructure over the easterly breakwater and north pier, and to rebuild superstructure over the southerly breakwater, outer basin, and over a part of the south pier, about 1,200 feet in length, at the mouth of the Chicago River, just north of the Illinois Central Railroad Pier No. 1. A joint resolution was passed by the last Congress authorizing the temporary licensing of the use of this pier by the Secretary of War, which license would have relieved the United States from the maintenance of this pier, and allowed its use for commercial purposes. A great local opposition was developed to such license and it has never been issued. The pier is now in a condition that requires repair. There is no good reason why it should not be now abandoned by the United States and allowed to become a part of the wharfage or dockage of the Chicago River under control of the officials of the city of Chicago, even as the rest of the piers which by natural or other causes have been brought within the low-water shore lines of Lake Michigan.

The laws of the United States are sufficient to guard against obstructions to navigation by improper uses of such inland piers, and their further maintenance by the United States is an unnecessary expense.

Money statement.

July 1, 1890, balance unexpended.....	\$17,565.17
Credit amount deposited to appropriation by Quartermaster's Department (fuel account)	27.65
Amount appropriated by act approved September 19, 1890.....	100,000.00
	<hr/>
	117,592.82
June 30, 1891, amount expended during fiscal year	21,589.62
	<hr/>
July 1, 1891, balance unexpended.....	96,003.20
July 1, 1891, outstanding liabilities.....	\$1,500.00
July 1, 1891, amount covered by uncompleted contracts.....	76,835.38
	<hr/>
	78,335.38
	<hr/>
July 1, 1891, balance available.....	17,667.82
	<hr/>

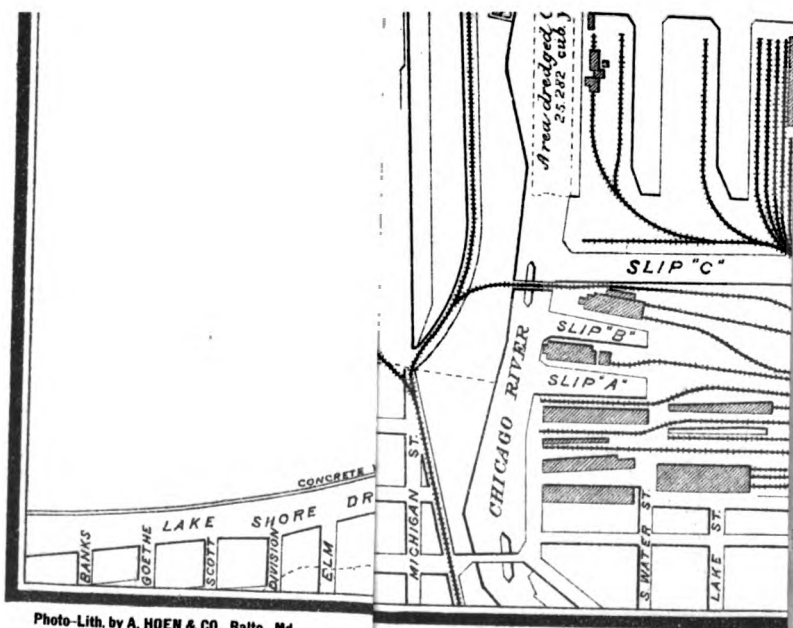


Photo-Lith. by A. HOEN & CO., Balto., Md.

{ Amount (estimated) required for completion of existing project.....	\$72,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	72,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for rebuilding superstructure at Chicago Harbor, Illinois, opened at Chicago, Ill., December 13, 1890, at 12 m., by Capt. W. L. Marshall, Corps of Engineers.

No.	Name and residence of bidder.	Pine, per M feet, B. M.		Wrought iron, per pound.					White-oak piles, each.		Totals.
		Timber in the work, 2,054,262 feet, B. M.	Decking in place, 419,440 feet, B. M.	Drift bolts in the work, 189,901 pounds.	Spikes in the work, 25,166 pounds.	Screw bolts, N's and W's, in the work, 337 pounds.	Dredge chain in place, 942 pounds.	Stone in the work, 1,839 cords, per cord.	In place 40 feet long, 28 piles.	In place 35 feet long, 21 piles.	
				Cents.	Cents.	Cents.	Cents.				
1	Truman & Cooper, Manitowoc, Wis.	\$29.00	\$20.00	3	3	4	12	\$6.00	\$15.00	\$14.50	\$86,252.23
2	Culbert & Lutz, Michigan City, Ind.	38.00	22.70	3½	3.35	3	10	5.50	13.60	11.90	105,170.83
3	Charles Burner, Green Bay, Wis.	31.00	22.00	3¼	4	4	6	5.50	18.00	15.75	91,084.27
4	The Heidenreich Co., Chicago, Ill.	28.98	22.00	3½	4	4	14	5.95	14.00	10.50	87,345.95
5	Green's Dredging Co., Chicago, Ill.	33.50	21.00	5	5	5½	6½	5.75	12.80	11.55	99,610.57
6	Kimbell and Cobb Stone Co., Chicago, Ill.*	29.00	24.00	3	4	5	10	4.50	14.00	12.00	85,335.38
7	Hiero B. Herr & Co., Chicago, Ill.	32.00	19.00	3	4	5	10	5.50	16.00	14.00	91,337.96
8	The Fitz Simons & Connel Co., Chicago, Ill.	28.00	25.00	4	4	7	5	6.00	12.00	10.50	88,250.61

* The lowest bidders.

The amount available for payments under a contract for this work is \$105,000.

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., June 30, 1891.

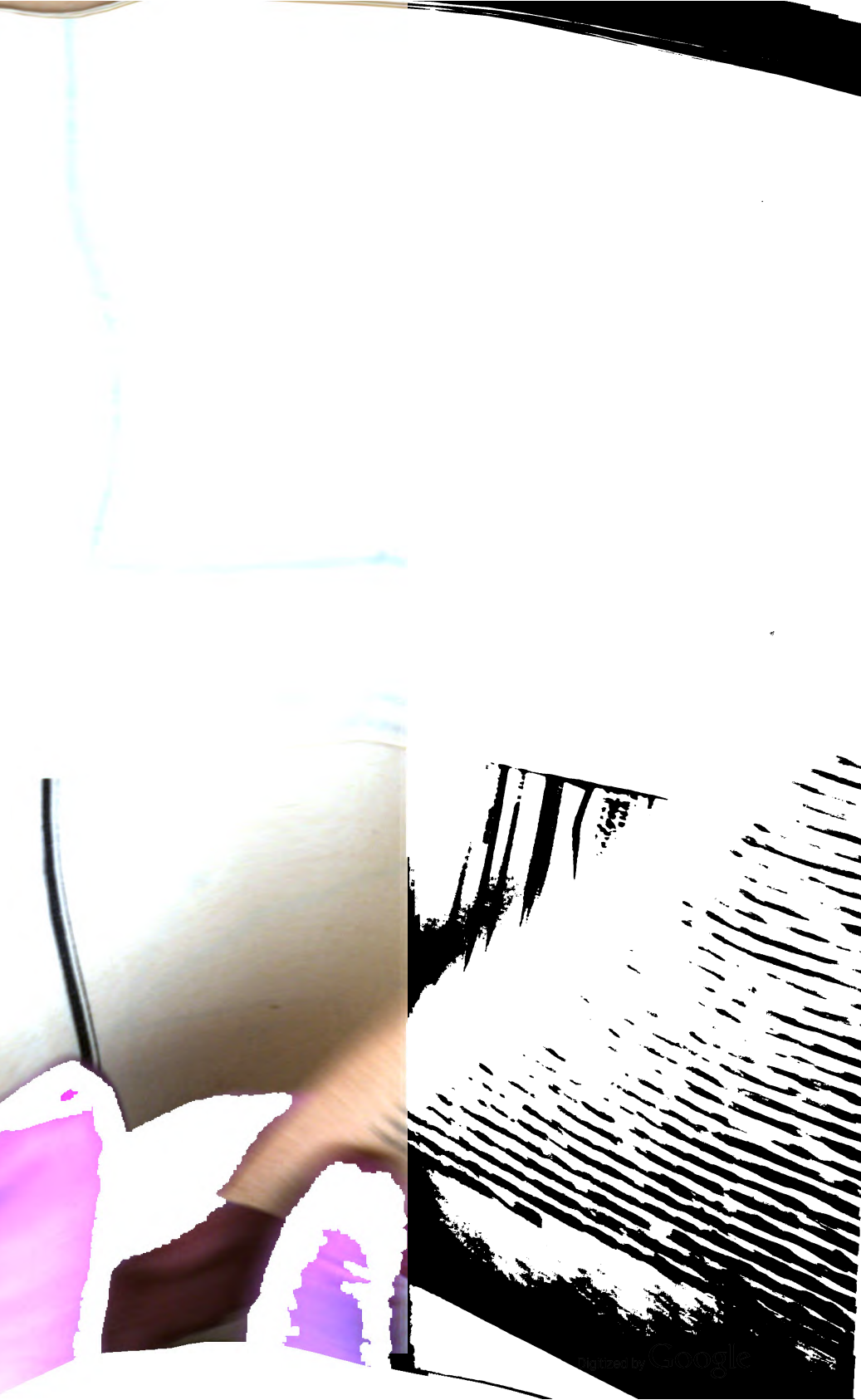
CAPTAIN: I have the honor to submit herewith a report of operations in Chicago Harbor, Illinois, for the fiscal year ending June 30, 1891.

The work done during the year consists in placing heavy timber decking over the exterior breakwater, and rebuilding superstructure over the northerly portion of the easterly breakwater to a height of 6 courses (= 6 feet).

Work done and material used for this purpose has been as follows:

THE EXTERIOR BREAKWATER.

A portion of the exterior breakwater had been decked over during the previous year with 3-inch plank, but a few heavy northerly gales proved the insufficiency of this covering, as it was soon broken to pieces. Another plan was then devised, which served two very desirable purposes, viz: First, to secure a substantial covering, as protection for the stone filling for this very much exposed breakwater, and secondly, to dispose of a large quantity of timber, piled on the easterly breakwater since 1883, which by the long exposure had become unfit for any other use, and which also would have formed a serious obstruction to the contemplated work of rebuilding the superstructure over the last-named breakwater. The work of putting down the new decking commenced on the 9th of October, 1890, and was completed on the 13th of December following.



4,461,568 feet,
making a total
of pine timber

d in the above

posals for rebuilding superstructure at Chicago Harbor, Illinois, and
., December 13, 1890, at 12 m., by Capt. W. L. Marshall, Corps of Eng.

north of the con-
 completed. The
 1800 feet south of
 the new timber has

work had been com-

by the United States
and thereby.
in launch, at the foot
been thoroughly over-

work of building super-
water and over the north
of the north pier, at the
of the "return," and to
tioned of these places, all

nd condition, and the easterly
on as the work now in progress
tion of the work is maintained
fulfilled within the specified time.
d should it have to be used by the
extant, which, however, is not likely
uperstructure; otherwise this is not

in good condition.
the fiscal year, is respectfully submitted

Obedient servant,
 G. A. M. LILJENCRA NTZ,
Assistant Engineer.

REPORT OF MR. G. A. M. HILTON

COMMERCIAL STATISTICS.

et is Chicago, Ill.

is Chicago, Ill. Amount of revenue collected at the the last fiscal year, \$5,794,515.51.

of vessels during the calendar year 1890, port of Chicago.

Description.	Arrived.		Cleared.	
	No.	Tons.	No.	Tons.
.....	4, 974	3, 280, 044	4, 993	3, 340, 795
.....	4, 214	1, 064, 458	4, 291	1, 088, 799
.....	9, 188	4, 344, 502	9, 284	4, 429, 594

transportation were established during the fiscal year. It is not to report the actual draft of vessels entering this harbor, but it is to report the draft of vessels entering this harbor, but it is not to exceed 16 feet, which is the depth of water in the channel. It is not less than that can enter the harbor without difficulty.

The following materials were used:

Pine timber	feet, B. M.	69, 686
Hemlock timber	do.	666, 266
Culled timber	do.	237, 610
Total	do.	973, 572
Wrought-iron drift bolts	pounds.	71, 471

Of the above amount of bolts only 6,384 pounds had to be purchased, the balance, 65,087 pounds, being on hand, the same as the timber.

The decking thus made covers the northerly two-thirds, about, of the width of the breakwater throughout its entire length, except about 450 linear feet of the outer or easterly end, which is covered to its full width, which was done as far as the available timber held out. The dimensions of the timber used were 10 by 12 and 12 by 12 inches.

THE EASTERLY BREAKWATER.

The easterly breakwater and the north pier have for a number of years been in the most deplorable condition, as has been regularly reported every year. Their respective ages warrant this condition. The westerly 400 linear feet of the latter pier was built in 1868, and is consequently now 23 years old. The easterly end (600 linear feet) is 15 years old, having been built in 1876. Though not by far as old as the other part, this end is also in a very bad condition, to a great extent aggravated by damages sustained by steamers running into the same on several occasions, the worst of which happened in 1881, when a steam-barge ran into the east end wall, breaking off all the timbers above and five courses below the mean lake level.

The easterly breakwater was built between 1871 and 1875, being thus from 16 to 20 years old in its different parts. Its state of decay proves its age conclusively.

It was originally intended to build permanent concrete superstructure over these piers similar to the 95 linear feet of that class of work designed by Maj. Thomas H. Handbury, Corps of Engineers, U. S. Army, and built, in 1887, about midway on the easterly breakwater; but considering the uncertainty, suggested by protracted local controversies, as to whether the inclosed basin ever will become utilized to any extent by the shipping interests or not, it was considered best to defer for the present the more expensive concrete work and substitute the ordinary kind of timber superstructure, which will last at least 12 years, by which time it is reasonable to expect that the vexatious lake-front controversy will be finally disposed of, when, if required, it will be time enough to build a permanent superstructure.

The timber superstructure, costing only about one-third the price for the concrete work, also makes it possible to renew, with available funds appropriated by act of Congress approved September 19, 1890, the whole length of both the easterly breakwater and the north pier, an aggregate of 5,243 linear feet, more or less.

Bids for this work were advertised for on the 24th of November and opened on the 3d of December, 1890.

The contract was awarded to The Kimbell & Cobb Stone Company, of Chicago, the lowest responsible bidders, and entered into on January 5, 1891.

Work was commenced on the 9th of May, 1891, on the easterly breakwater.

The removal of the old work was much harder than anticipated, and the progress in the beginning was rather slow, and at the end of the month not quite 300 linear feet of new work had been completed, wherefore the contractors did not request any estimate at the close of that month; but after each gang of workmen became familiar with their work, and after the force had been considerably increased and new working appliances brought into service, the progress has been eminently satisfactory. Among the appliances referred to might be mentioned a large scow and derrick, with a 45-foot long boom thereon, for the handling of the timber. The scow will hold a considerable quantity of framed timber, which, by means of the long boom, is placed, each stick in its proper position, in the work, saving much labor usually done with cant hooks. At present nearly 40,000 feet, B. M., on an average, of timber is secured in place per day (on the 19th instant 42,800 feet, B. M., were put down).

On the 24th instant the contractors were given an estimate for work over 1,312 linear feet of the easterly breakwater, which distance was completed, with the exception of decking and stone filling; i. e., the work was filled to the required height, but with old stone transferred from other parts of the work (specifications provide that payments shall not be made for less than 100 linear feet of work completed, and for only even multiples of 100 feet). The portion of the easterly breakwater lying south of the concrete work is 2,112 feet in length, and the exception made from the said rule in the above estimate was to dispose of the 12 feet in excess of the even multiple of 100 feet—2,100.

The work paid for contained the following amounts of materials, viz, 461,568 feet, B. M., of pine timber and 44,818 pounds of wrought-iron drift bolts, making a total of work under this contract during the fiscal year of 749,240 feet, B. M., of pine timber and 70,513 pounds of wrought-iron drift bolts.

A portion of the decking has been put down, but is not included in the above figures, not being as yet in condition to be accepted.

With the exception of the decking the portion of the breakwater north of the concrete work—not including the return, however—is now very nearly completed. The work of taking up the old superstructure has also been commenced 800 feet south of the concrete work and at the west end of the north pier, and some new timber has been put down in the former place.

At the close of the year not less than 1,700 linear feet of the work had been completed, with the exception of the decking.

There has never been any safe place in this harbor for keeping the United States steam tug and steam launch, and these boats have suffered much thereby.

A boat house has therefore been built, as a shelter for the steam launch, at the foot of Randolph street, the more needed now, after the launch has been thoroughly overhauled and put in good repair.

It is proposed, during the ensuing year, to continue the work of building superstructure over the remaining portion of the easterly breakwater and over the north pier, and also to build the pile protections at the east end of the north pier, at the north end of the easterly breakwater, and at the west end of the "return," and to repair the damages by collisions at the first and last mentioned of these places, all in accordance with existing contract.

CONDITION OF THE WORKS.

The exterior and southerly breakwaters are in good condition, and the easterly breakwater and the north pier will be likewise as soon as the work now in progress is completed; and if the present energetic prosecution of the work is maintained there is little doubt but that the contract will be fulfilled within the specified time.

The south pier is in a dilapidated condition, and should it have to be used by the United States Government to any considerable extent, which, however, is not likely to be the case, then it should be given a new superstructure; otherwise this is not of any material importance.

The channel at the entrance to the river is in good condition.

A tracing, showing the work done during the fiscal year, is respectfully submitted herewith.

I am, captain, very respectfully, your obedient servant,

G. A. M. LILJENCRAFT,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The nearest collection district is Chicago, Ill.

The nearest port of entry is Chicago, Ill. Amount of revenue collected at the nearest port of entry during the last fiscal year, \$5,794,515.51.

Arrivals and clearances of vessels during the calendar year 1890, port of Chicago.

Description.	Arrived.		Cleared.	
	No.	Tons.	No.	Tons.
Steam	4, 974	3, 280, 044	4, 993	3, 340, 785
Sail	4, 214	1, 064, 458	4, 291	1, 088, 799
Total	9, 188	4, 344, 502	9, 284	4, 429, 584

No new lines of transportation were established during the fiscal year.

It is impracticable to report the actual draft of vessels entering this harbor, but it may be stated as not exceeding 16 feet, which is the depth of water in the channel, and vessels drawing less than that can enter the harbor without difficulty.

Receipts and shipments by lake during the calendar year 1890.

Receipts.		Shipments.	
Article.	Quantity.	Article.	Quantity.
	<i>Tons.</i>		<i>Tons.</i>
Coal	1, 188, 505	Flour	180, 351
Lumber	2, 873, 284	Grain	2, 038, 062
Iron and iron ore	126, 145	Lard	53, 501
Flour, salt, and sugar	117, 976	Meats	8, 328
Stone and ice	78, 810	Lead	36, 145
Cement	21, 153	Seeds	77, 588
Potatoes	10, 112	Oil cake	32, 684
Miscellaneous merchandise	289, 772	Miscellaneous merchandise	102, 000
Total	4, 685, 757	Total	2, 523, 757

M M 2.**IMPROVEMENT OF CALUMET HARBOR, ILLINOIS.**

The object of this work is to provide a deep entrance to Calumet River and the port of South Chicago, Ill.

This is effected in the usual manner by dredging a channel and protecting the dredged area by parallel piers 300 feet apart projecting into the lake from the river's mouth.

CONDITION OF THE WORK JUNE 30, 1891.

Work was begun on this harbor in 1870, and at the beginning of the fiscal year 2,020 linear feet of the south pier and 3,640 linear feet of the north pier had been constructed, which completed the existing project as far as pierwork is concerned, but the south pier should be prolonged 800 feet to protect the channel from drifting sands.

On account of the present urgent necessity for maintaining the work already done, the superstructure of the piers being rotten over an extent of 2,000 linear feet and in bad condition over 800 feet in addition, the estimate herewith submitted is entirely for maintenance, and contemplates no further extension of piers at the present time.

The river and harbor act of September 19, 1890, appropriated \$20,000 for this work, and in accordance with the project for its expenditure, approved by the Chief of Engineers, proposals were sought for by public advertisement for dredging the channel between the piers, which had deteriorated until there was no longer a practicable channel 16 feet in depth.

Proposals were received and opened November 19, 1890, as shown in table appended.

With the approval of the Chief of Engineers contract was entered into December 10, 1890, with W. A. McGillis & Co., of South Chicago, Ill., the lowest responsible bidders, at 13½ cents per cubic yard.

Work under this contract commenced April 27, 1891, at the westerly end of the harbor, connecting with the Calumet River improved channel.

At the close of the fiscal year a channel 250 feet wide to a depth of 17 feet below the United States harbor datum (1 foot above extreme low water) and 750 feet in length has been completed, involving the dredging of 29,088 cubic yards.

The price secured by the United States for this dredging, being about

two-thirds the estimated cost, will allow a wide channel, 16 feet in depth at low water throughout this harbor, to be secured, connecting with the improved river channel, and leave this important harbor in far better condition than heretofore.

In addition, too, to the United States dredging, the Illinois Steel Company are continuing the dredging to the depth of 20 feet below United States harbordatum as far as to their slip, for the accommodation of the heavy ore-carrying vessels that supply their extensive works. In view of this work by this corporation there will probably be no demand for a deeper channel. This dredging should not have been necessary for private parties at their own expense.

The importance of the harbor is rapidly increasing as a consequence of the dredging of the Calumet River by the United States to a depth of 16 feet and a width of 200 feet now in progress, which makes desirable as manufacturing property much of the adjacent land heretofore denied water transportation in large craft.

Manufacturing establishments of magnitude are seeking this region, and the wonderful growth of Chicago and vicinity will amply justify all expenditures upon this harbor.

There are influences at work that will either diminish the uses of Chicago River and increase the demands upon the Calumet harbor and river, or else require the thorough enlargement and rectification of the Chicago River to accommodate the enormous commerce now dependent upon the navigation of that stream. It is probable then that the Calumet Harbor will rapidly become one of the most important upon Lake Michigan and should continue to receive the consideration that its position demands.

PROPOSED APPLICATION OF FUNDS ASKED FOR, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

It is proposed to apply these funds entirely for rebuilding and maintenance of the piers and revetments protecting the entrance to Calumet River.

A report herewith of Assistant Engineer G. A. M. Liljencrantz, gives in detail the work done during the past fiscal year and the present condition of this work.

Money statement.

July 1, 1890, balance unexpended	\$4, 182. 24
Amount appropriated by act approved September 19, 1890	20, 000. 00
	<hr/>
June 30, 1891, amount expended during fiscal year	24, 182. 24
	<hr/>
July 1, 1891, balance unexpended	3, 251. 70
July 1, 1891, amount covered by uncompleted contracts	
	<hr/>
July 1, 1891, balance available	20, 930. 54
	<hr/>
July 1, 1891, amount covered by uncompleted contracts	9, 691. 20
	<hr/>
July 1, 1891, balance available	11, 239. 34
	<hr/>
{ Amount (estimated) required for maintenance	32, 000. 00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	32, 000. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

2604 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

Abstract of proposals for dredging received and opened at Chicago, Ill., 12 m., Wednesday, November 13, 1890, by Capt. W. L. Marshall, Corps of Engineers.

No.	Name and residence of bidder.	Estimated rate per yard (90,000 yards.)	Total.
		<i>Cents.</i>	
1	W. A. McGillis & Co., South Chicago.....	13½	\$12, 150
2	McMahon & Montgomery, Chicago.....	23	20, 700
3	Green's Dredging Co., Chicago.....	25	22, 500

The amount available for payments under a contract for this work is \$21,000.

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., June 30, 1891.

CAPTAIN: I have the honor to submit herewith a report of operations in Calumet Harbor, Illinois, during the fiscal year ending June 30, 1891.

The work done in the harbor during the year consisted in dredging between the piers to a depth of 17 feet below the United States harbor datum.

By an act of Congress approved September 19, 1890, the sum of \$20,000 was appropriated for continuing the improvement of Calumet Harbor, Illinois.

Both dredging of the main channel and repairs, by way of rebuilding the superstructure over both the piers, were very much needed, but the funds available not being sufficient to accomplish both, it was considered of chief importance to apply the appropriation to dredging, on purpose to secure a connection between the lake and the improved portion of the river, very much in demand by the steadily increasing navigation.

Bids for dredging were advertised for October 20, and opened November 19, 1890. The contract was awarded to W. A. McGillis & Co., of South Chicago, Ill., the lowest responsible bidders, and entered into December 10 following, at the very low rate of 13½ cents per cubic yard.

The work commenced on the 27th of April, 1891, at the westerly end of the harbor, connecting with the channel improved under appropriations for the Calumet River.

Up to the end of the fiscal year 29,088 cubic yards have been removed, completing a channel 250 feet wide and to the required depth, 17 feet, for a distance of 750 feet, or up to the entrance of the Illinois Steel Company's Slip. This will represent a cost of \$27,646 per mile of channel completed.

In addition to this dredging, the Illinois Steel Company has kept a dredge at work making a channel 20 feet deep and about 70 feet wide from the lake to their slip, to admit the passage of their heavily laden ore vessels.

The distance between the piers is 300 feet, but the dredging is done to a width of 250 feet only, leaving 25 feet along each pier on purpose to prevent loss of stone or other damage to the work.

It is proposed during the ensuing year to continue the dredging until a channel of the specified width and depth has been completed, which will connect the improved river channel with deep water in Lake Michigan.

By the terms of the contract it is stipulated that the work shall be completed on or before August 31, 1891, and it is confidently believed that this will be complied with.

CONDITION OF THE PIERS.

The extremely bad condition of the westerly or shore ends of both the piers has been periodically reported for several years, and the work of time continues unceasingly, as illustrated by the table below, which gives the lengths and conditions of the different portions of the two piers.

Condition.	North Pier.	South Pier.	Total.
	<i>Linear feet.</i>	<i>Linear feet.</i>	<i>Linear feet.</i>
Good.....	1, 648	500	2, 148
Fair.....	350		350
Bad.....	506	300	806
Worthless.....	1, 011	990	2, 001
Removed for making slips.....	125	230	355
Total lengths.....	3, 640	2, 020	5, 660

stone filling put into both piers in 1889 is still in good condition, having set out slightly along the northerly side of the north pier, but not noticeably elsewhere.

South Chicago, the town at which this harbor is located, now lying within Chicago city limits, has shown a remarkable activity during the past year. Several streets have been raised from their originally low level to a uniform grade 10 feet above Chicago city datum, and this work is still steadily progressing. A number of enterprises commenced during the previous year have been completed and new ones begun or projected.

Among the more prominent ones, in the immediate vicinity of the harbor, are:

The Illinois Steel Company, mentioned in last year's report. A great amount of money has been expended on these works during the year, as may be inferred from following statements:

The plant now in operation consists of 8 furnaces, 21 by 75 feet; a Bessemer plant with 3 10-ton vessels; a 40-inch 3-high blooming mill; a 27-inch 3-high rail train, and all facilities for handling a large output of rails. The blast furnaces furnish about 1,800 tons of metal per day.

The completion of the new furnaces, the open-hearth plant, and the plate mill will, it is claimed, make this the largest establishment in this country.

Nearly all the ore for the supply of 15 furnaces will be unloaded at the docks of this plant. To provide for this immense business, which must be done in seven months of the year, the new harbor and ore-handling machinery have been put in, and it is expected that shortly 5,000 tons of ore can be handled per day on the new docks. Crude petroleum oil is used for firing the boilers, and this is piped to the works from Lima, Ohio, 208 miles distant.

2. The National Smelting and Refining Company, south of the harbor, was mentioned in the last year's report as being in process of construction.

These works have been completed during the year and are in active operation.

3. The Calumet planing mill, sash and door factory, etc., has been erected during the year near the Ninety-second street bridge, and gives employment to 80 men.

No work of improvement having been done to piers as recommended, but the work "in need of repairs" being somewhat extended, the estimated cost of work required will be:

1,681 linear feet of new superstructure, at \$15.34 per linear foot.....	\$25,786.54
320 linear feet of sheet piling, at \$8 per linear foot.....	2,560.00
Total	28,346.54
Add 10 per cent. for contingencies, etc.....	2,834.65
Total	31,181.19

Soundings were carefully taken between the piers by Mr. Paul Heinze, overseer, before the dredging commenced.

A tracing, showing soundings and in general the work done during the year and the location of the Illinois Steel Company's new harbor, is respectfully submitted herewith.

I am, captain, very respectfully, your obedient servant,

G. A. M. LILJENCRANTZ,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The harbor of Calumet is at South Chicago, in the collection district of Chicago.

There is a light-house and a keeper's dwelling on the Government reservation near the shore end of the north pier. A beacon light is maintained at the extremity of the north pier to mark the entrance to the harbor.

Amount of revenue collected at the nearest port of entry (Chicago) during the fiscal year, \$5,794,515.51.

Arrivals and clearances of vessels during the calendar year 1890.

Description.	Arrivals.		Clearances.	
	No.	Tons.	No.	Tons.
Steam	574	633,987	528	566,064
Sail	286	73,684	273	68,161
Total	860	707,670	801	634,225

This shows an increase over 1889 of 161 arrivals and 157,045 tons, and of 145 clearances and 136,363 tons.

No new lines of transportation were established during the fiscal year.

Before the publication of this report there will be secured at this harbor under the present contract an available depth of water throughout the harbor of 18 feet at the mean level of Lake Michigan and of 16 feet at extreme low water.

Receipts and shipments by lake during the calendar year 1890.

Receipts:	Tons.
Coal.....	98,000
Iron ore.....	703,149
Salt.....	42,390
Lumber.....	911,800
Miscellaneous merchandise.....	20,736
Total.....	1,776,075
Shipments:	
Grain.....	20,326

M M 3.

IMPROVEMENT OF CALUMET RIVER, ILLINOIS AND INDIANA.

The object of this work, as far as at present authorized, is to secure a channel 200 feet wide and 16 feet deep below United States harbor datum (which is 1 foot above extreme low water and about 1 foot below the mean lake level of Lake Michigan) from the mouth of the river to one-half mile east of Hammond, Ind., to increase the facilities for handling the commerce of this region and to afford relief to the overcrowded port of Chicago.

The history of the work is given in previous reports of the Chief of Engineers prior to the report of 1890, and a résumé of the provisions of the river and harbor acts of July 5, 1884, August 5, 1886, and August 11, 1888, under which has been done all work on this river previous to that reported herein, will be found on page 2142, Report of the Chief of Engineers for 1889.

Although the project contemplates the ultimate attainment of 16 feet depth of navigation over a width of 200 feet from the mouth of the Calumet River, at Calumet Harbor, to a point one-half mile east of Hammond, Ind., it will be seen from the acts cited that this stretch has heretofore been divided into two sections:

(1) From the mouth of the Calumet to the Forks of the Calumet River.

(2) From the Forks of the Calumet to one-half mile east of Hammond, Ind., and the work previous to the fiscal year 1891 has been done under separate allotments for the two sections.

During the past fiscal year no work has been done on the second section, or between the forks and one-half mile east of Hammond, Ind.

At the close of the last fiscal year work was in progress under a contract with W. A. McGillis & Co., of Havana, Ill., which had been extended to November 30, 1890.

During the last fiscal year this contract has been completed, and a channel 200 feet wide and 16 feet in depth was completed practically to One-hundred-and-eighth street, 393,112 cubic yards of material having been removed under this contract, or 771,737 cubic yards in all.

The river and harbor act approved September 19, 1890, appropriated for this work \$50,000, and, with the approval of the project by the Chief of Engineers, proposals were solicited October 20, 1889, for the contin-

uation by dredging of this work from the vicinity of One hundred and eighth street southward, which proposals were received and opened November 19, 1890.

With the approval of the Chief of Engineers, U. S. Army, contract was entered into December 10, 1890, with Wheeler & Pursell, of Portsmouth, Ohio, the lowest responsible bidders, at a price of 12 $\frac{1}{4}$ cents per cubic yard, measured in place.

Work under this contract commenced April 6, 1891, and at the close of the fiscal year 1891, 72,111 cubic yards of material had been removed, 32,111 cubic yards of which had been paid for. Up to the close of the fiscal year 1891, 843,848 cubic yards of material in all, since inception of the work, had been dredged from this channel, completing 2 miles and 2.033 feet to the full width and depth of channel.

The details of this work and the cost per mile thereof are given in the report of Assistant Liljencrantz, herewith, and reference is respectfully made thereto.

This river is rapidly growing in importance and its improvement is greatly stimulating manufacturing enterprises, the commerce of the river and harbor increasing at the rate of about 30 per cent. per annum each year since the improvement began.

The improvement of the river, however, seems to be in advance of the uses of the bordering lands; but little comparatively speaking is docked, and the watershed of the Calumet being large and the current swift at spring freshets, the dredged channel deteriorates rapidly both from sediment brought into it and from the wash from the undocked sides.

Recent soundings show a deterioration of over 1 foot in the channel already dredged from these causes, and soon we will reach a point, if annual appropriations be not increased, where the entire available appropriation will be required to maintain the depth and width of navigation required, and no further progress be made on the main work. Either the United States must decline to maintain a channel once secured here or make greater annual appropriations;

(1) To maintain what has been gained.

(2) To further prosecute the work, or else at some point near by to abandon further extension of the work until it is properly docked along completed channels, and the work of maintenance be assumed by the local interests involved. As this river and lakes connected with it form a very valuable system of navigation, and as work now contemplated by the city of Chicago may possibly diminish the value of the Chicago River as a navigable stream, and consequently increase the importance of the Calumet River, it is growing more and more worthy of improvement by the General Government. Particularly, in my opinion, is it advisable for Congress to assume by a special bridge law applicable to this river control of the matter of bridging the river, and also by law prevent the obstructing of the channel by the deposit therein of solid matters through sewers and slaughter-house drains, etc.

The United States has secured the riparian rights along the river from its mouth to its forks, and should not only continue its improvement, but prevent all structures and uses that may diminish its value as a free public highway. The region will sometime be densely populated, and encroachments upon this channel way will reduce it to the same conditions, if not prevented at the outset, as are now presented by the Chicago River.

In the execution of the work upon this river by the contractors, work was stopped April 22, 1891, by service of process in an ejectment suit

of A. A. Westengard, claiming to own certain submerged lots, part of which, as plotted, extended into the deepest navigated channel of the Calumet River, upon the contractors' agents and upon the United States inspector of dredging.

The lots claimed being submerged, neither the claimant nor the opposite party had ever set foot upon them or could say whether or not the dredge was then upon the property claimed. Dredging, however, was at once stopped, and the dredge removed to a part of the work within approved dock lines where no contention existed. Subsequent surveys showed that the dredge had not touched any property within 100 feet of the claimed lots.

This matter is now in the hands of the United States district attorney for the northern district of Illinois, to protect the interests of the United States therein.

Doubtless this ejectment suit must be dismissed, but the right of the United States to improve navigation by deepening channels within the low-water lines of navigable rivers will come up and be decided in this case under some other form of proceeding.

The plaintiff claims title to submerged lands to the center of the channel, and that the United States can not dig up his lands without compensation therefor. If his claim holds in the courts the general improvement of non-tidal rivers by the General Government, by deepening channels, constructing dams, locks, and other works of navigation, must be put upon a different basis than at present.

PROPOSED APPLICATION OF FUNDS NOW AVAILABLE AND THOSE ASKED FOR, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

It is proposed to expend the funds now available in continuing work under the contract now in force, and to apply the funds asked for in continuing the approved project towards completion as far as moneys appropriated will go.

Money statement.

July 1, 1890, balance unexpended.....	\$51,790.28
Amount appropriated by act approved September 19, 1890,.....	50,000.00
	<hr/>
	101,790.28
June 30, 1891, amount expended during fiscal year.....	57,388.91
	<hr/>
July 1, 1891, balance unexpended.....	44,401.37
July 1, 1891, amount covered by uncompleted contracts.....	41,172.26
	<hr/>
July 1, 1891, balance available.....	3,229.11
	<hr/>
{ Amount (estimated) required for completion of existing project.....	820,000.00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	200,000.00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for dredging received and opened at Chicago, Ill., 12 m., Wednesday, November 19, 1890, by Capt. W. L. Marshall, Corps of Engineers.

No.	Name and residence of bidder.	300,000 yards, estimated rate per yard.	Total.
		<i>Cents.</i>	
1	Wheeler & Pursell, Portsmouth, Ohio.....	12½	\$36,750
2	W. A. McGillis & Co., South Chicago.....	15	45,000
3	Green's Dredging Co., Chicago.....	14	42,000

The amount available for payments under a contract for this work is \$45,000.

tract of contracts for improving Calumet River, Illinois and Indiana, in force during the fiscal year ending June 30, 1891.

name and address of contractor.	Nature of contract.	Date.	To expire.
A. McGillis & Co., South Chicago, Ill.*	Dredging 770,000 cubic yards from between the mouth and One hundred and eighth street, at 11½ cents cubic yard.	Nov. 5, 1888	Apr. 30, 1891
Wheeler & Pursell, Portsmouth, Ohio.	Dredging 365,000 cubic yards, at 12½ cents cubic yard.	Dec. 10, 1890	Nov. 30, 1891

* Completed December 22, 1890.

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE.

Chicago, Ill., July 1, 1891.

CAPTAIN: I have the honor to submit herewith a report of operations in Calumet River, Illinois and Indiana, during the fiscal year ending June 30, 1891:

The work during the year consisted in, first, continuing the dredging, under contract dated November 5, 1888, with W. A. McGillis & Co. (then of Havana, now of South Chicago, Ill.), which had not been completed during the previous year; and, secondly, by dredging, in continuation of the improvement under contract with Messrs. Wheeler & Pursell, of Portsmouth, Ohio, dated December 10, 1890.

The first named of these contracts was to have expired on the 30th of November, 1890, but at the request of the contractors, dated November 12 of the same year, the time for fulfillment of the contract was extended to November 30, 1890, subject to provisions in the specifications with regard to extra expenses on account of the extension of time, etc. The contract was completed on December 21, 1890.

Up to that time a total of 771,737 cubic yards had been removed under the contract, which amount 393,112 cubic yards were removed during the fiscal year ending June 30, 1891. This work was all done at the rate of 11½ cents per cubic yard.

The amount of \$50,000 having been appropriated by act of Congress approved September 19, 1890, for continuing the improvement of "Calumet River, Illinois and Indiana," bids were advertised for October 20, 1890, and opened November 19 following, for doing this work. The contract was awarded to Wheeler & Pursell, of Portsmouth, Ohio, the lowest responsible bidders, and entered into on December 10 of the same year, at a price of 12½ cents per cubic yard.

Work under the new contract was commenced April 6, 1891, but only one estimate has so far been given the contractors for reasons given below.

The amount of work paid for on June 11, 1891, was 32,111 cubic yards. Since that time and up to the end of the fiscal year there has been further removed from the channel about 40,000 cubic yards under this contract.

The total amount of dredging done up to the end of the fiscal year will then be as follows:

	Cubic yards.
Under old contract to June 30, 1890.....	378, 625
During present year, old contract.....	393, 112
During present year, new contract.....	72, 111
	<hr/> 465, 223
Total since beginning of the improvement.....	843, 848

The total length of channel dredged up to the end of the fiscal year is 2 miles and 633 feet, of which 2 miles and 1,605 feet was dredged under the old contract and the balance, 428 feet, under the new. The work under the different contracts at different prices and along different portions of the river, etc., will give the averages of cost per mile as follows:

Under old contract.....	\$39, 356
Under new contract.....	48, 527
Cost of work done to date.....	39, 670
As per estimate for new contract.....	59, 755

The great difference in cost of the work under the old and new contracts is caused by, first, the slightly increased contract price from 11½ to 12½ cents per cubic

yard; secondly, by the greater amounts of excavation in the same length of channel owing to the existence originally of a deeper and wider channel in the river near to the mouth than further up; and finally, and to the greatest extent, by the deviation of the new channel lines, along which work is in progress under the new contract, from the natural channel, which was done to secure more readily right of way for the improvement. This brings in some cases the new channel so far away from the old as to leave the latter entirely outside of the limits of the former, where accordingly there is a cut clear across of from 15 to 16 feet.

Though this increases the amount of dredging originally estimated for, it was found necessary to make the change in the channel lines intimated, to avoid sundry lots on the east bank of the river, where some owners were unwilling to convey to the Government.

Even in spite of this precaution, the work has been seriously interfered with by one of the owners just referred to, who on the 22d of April last entered suit of ejectment against the contractors, even when the dredge had not reached further than within about 170 feet of the lots in dispute.

I understand that a special report has been made by you on this matter, but it mentioned here on purpose to show the slight progress made by the contractors.

After the contractors had been given due notice of the suit, by a deputy sheriff they were put to work further up the river, beyond the lots in question, but have not been able to finish up a section that could be measured for an estimate.

The 40,000 cubic yards given above as having been dredged since the payment made in May is an approximation only, but is considered close to the correct amount.

No work has been done in the upper part of the river between Calumet Lake and Hammond, Ind., during the year.

The importance of the improvement of Calumet River is shown by the new enterprises of vast proportions already established or projecting to locate along its bank.

Among the more important ones now in operation, is the Iroquois Furnace Company, on the east side of the river, between Ninety-fifth street and the railroad bridges, making pig-iron to the extent of 250 tons per day. It employs 150 men.

Across the river from these works are the South Side Lumber Company, and Fisk Bennett & Co.'s grain elevators. The lumber company employs 50 men, and handles 20,000,000 feet B. M. per annum.

There are two elevators, one of which has been built during the year.

The old elevator handles 70,000 and the new one 100,000 bushels of grain per annum.

Further up, on the Grand Calumet River, at Tollestons, Ind., has just been started works that will undoubtedly have a great influence on the future development of the river region.

This is not a "new enterprise," in one sense, but the removal from Chicago to this place of the most wealthy and prominent of the meat packers, Messrs. Swift, Armour & Morris, who have secured a tract of 4,000 acres, on which they propose to establish new union stock yards, with all necessary railroad connections, a canal from Calumet River, with a large basin in the surrounding marshes and a harbor into Lake Michigan, thereby taking the initial step towards the foundation of a manufacturing town of great importance. Extensive and minute surveys have been completed and bids have been advertised for, for the construction of the canal and other work.

Mr. Paul Heinze, overseer, has made all the surveys and Mr. Stephan Creutz has acted in the capacity of local inspector, both of which gentlemen have rendered efficient and faithful services.

A tracing showing the work done, and another tracing indicating by sounding the results obtained from the year's work, are respectfully submitted herewith.

Very respectfully, your obedient servant,

G. A. M. LILJENCRANTZ,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

As the Calumet River and Harbor are so closely connected in their commercial relations, no commercial statistics are given in this place, but will be found under the head of Calumet Harbor. There is practically no navigation on the river beyond that at the harbor. As soon, however, as the river channel is opened by dredging, navigation and business along the river will develop very fast. It awaits only this opening.

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Photo-Lith. by A. NEER & CO., Baltimore, Md.

Before the dredging required can be done, an entire new outfit must be purchased, as far as floating plant is concerned.

PROPOSED APPLICATION OF FUNDS ASKED FOR, FOR THE FISCAL YEAR
ENDING JUNE 30, 1893.

It is proposed to apply the funds now on hand and those asked for to the completion of the Kampsville Lock and Dam; to renovating the dredging plant, and to dredging the channels through bars and completing the existing project.

Whatever may be the result of municipal or local works, the execution of which may make possible an improvement of the Lower Illinois by other methods than by locks and dams, it must be considered that even yet, nearly 2 years after the creation and establishment of an organization to carry on a work which was said to be sufficiently understood to justify the legislature of the State of Illinois to indicate to the United States the work required, on the basis of municipal necessity, and to direct the destruction of valuable works of navigation on the Illinois River, no definite plans have been worked out, formulated, and adopted. The channels proposed have been twice located and estimated, in part; but the details as yet are unknown, the rights of way unsecured, and the inauguration of the work still in the future.

Doubtless this municipal work will be executed as a sanitary necessity, but it will take many years for its inception and completion. Meanwhile the interests of navigation on the Illinois River should be provided for by the completion of the existing project now so near consummation, and the future course of the improvement be adjusted to the conditions that will be probably revealed in time. It would not now be wise to abandon a work that will certainly fulfill the requirements of navigation on the Lower Illinois at very small expense, because it is possibly in the next generation these works may be incidentally rendered unnecessary by the execution of work for another purpose and as yet not even begun.

Whenever the large channel contemplated by the city of Chicago for drainage is actually determined upon, in view of the fact that a channel for navigation and the channel for drainage across the Chicago divide must necessarily occupy the same field, it is evident that to avoid duplication of expense, the channel, at least in the expensive rock section, should be constructed best to meet the requirements of navigation—slope, velocity of current, and dimensions of section, while at the same time of sufficient flowing capacity to carry off the drainage of the unitary district. Such a compromise will necessarily be more expensive than either a channel best suited for drainage, or a channel best suited and sufficient for navigation. Elsewhere where locks and dams are necessarily used, and in the earth section, it may not seem advisable for the two channels to occupy the same location. The dams will obstruct the flow and the flow will make more expensive the dams and deprive the system of navigation more or less of its slack-water features and advantages. A current aids navigation downstream in direct proportion to its velocity within practicable limits, but obstructs upstream navigation nearly in proportion to its cube. A channel, therefore, with velocity of 3 miles an hour, or even less, can not be made equal in value to a similar slack-water channel.

It is doubtful whether there be anywhere on the face of the globe navigation in ordinary river channels by steamboats, upstream, more than 400 miles against a current of 3 miles an hour, or more, and in

competition with a good system of land carriage by rail that will pay expenses, much less reduce the cost of transportation, and it must be understood that all water routes between the Great Lakes and the Mississippi River contemplate the transfer of western produce upstream to the Great Lakes, not manufactured and other products downstream westward. It is then evidently of the first importance, if this route is to be used, that the voyage from the Mississippi to the Great Lakes be made as easily and with as little expenditure in time, fuel, oil, and wear and tear as possible. This condition can only be met over this route by slack-water pools or very moderate currents. It can not be met by 3 mile currents in artificial cuts, or even by large discharges over fixed dams in a river of steep slope, if the channels of this stream be not so greatly enlarged in capacity as to convert the pools approximately into reservoirs.

Under this view, in the report upon the water way from Lake Michigan to the Illinois River at La Salle (Annual Report Chief of Engineers U. S. A., 1890, page 2439), the opinion was expressed that a route navigable at all times and conditions could be had, in continuation of the improvement of the Illinois River to Lake Michigan, at practicable cost by a canal from Joliet to La Salle better than by an improvement in the bed of the river, when a large low-water artificial discharge is to be produced and maintained and the artificial discharge uncontrolled at higher stages.

This opinion is, however, contrary to reports of other engineers hitherto made to Congress, and is strongly opposed.

In considering the extension of this route to Lake Michigan, therefore, it seems that it should be investigated, in addition to the proper capacity and dimensions of the channel and works of navigation—

(1) Whether this extension should be made from La Salle to Joliet by the improvement in the bed of the Illinois River or by means of a lateral canal of proper width and depth.

(2) To what extent it is advisable for the United States to coöperate with local authorities in constructing a channel across the Chicago divide (rock cut) suitable for both local and national purposes, with a view to lessen the cost of construction to each.

(3) Can this be done, and in what way, without increasing the liabilities of the United States for damages to property by flowage from water not necessary for navigation but introduced through channels constructed in whole or part for public purposes by the United States?

The appended report of Assistant Engineer Wm. M. Childs gives a detailed description of all work done upon this improvement during the past fiscal year.

Money statement.

July 1, 1890, balance unexpended.....	\$5, 033.5
Amount appropriated by act approved September 19, 1890.....	200, 000.0
	<hr/>
	205, 033.5
June 30, 1891, amount expended during fiscal year.....	45, 728.5
	<hr/>
July 1, 1891, balance unexpended.....	159, 304.5
July 1, 1891, outstanding liabilities.....	\$2, 500.00
July 1, 1891, amount covered by uncompleted contracts.....	23, 901.04
	<hr/>
	26, 401.0
July 1, 1891, balance available	<hr/>
	132, 903.5
<hr/>	
{ Amount (estimated) required for completion of existing project.....	212, 500.0
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	212, 500.0
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Gauge readings on the Illinois River at Kampsville, Ill.

[Readings are referred to low water of 1879.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>
1.....	4.97	9.25	6.98	8.20	9.73	6.70	10.53	1.55	0.25	0.50	1.52	1.50
2.....	5.12	9.50	6.52	7.97	9.55	6.68	10.02	1.42	0.25	0.50	1.55	1.50
3.....	5.40	8.85	6.38	8.05	9.40	6.65	10.75	1.47	0.25	0.50	1.47	1.58
4.....	5.50	8.65	6.28	8.20	9.27	6.65	10.80	1.45	0.25	0.50	1.87	1.53
5.....	5.65	8.45	6.12	8.17	9.15	6.65	10.70	1.27	0.25	0.50	1.30	1.45
6.....	6.40	8.33	6.10	8.02	9.00	6.60	10.57	1.18	0.25	0.50	1.23	1.38
7.....	6.63	8.20	6.25	7.95	8.82	6.60	10.48	1.05	0.22	0.50	1.12	1.33
8.....	6.73	8.00	6.18	7.83	8.55	6.57	9.98	0.92	0.35	0.50	1.02	1.30
9.....	6.88	7.70	6.00	7.75	8.30	6.62	9.53	0.80	0.37	0.53	0.90	1.30
10.....	7.30	7.60	6.40	7.65	8.08	6.95	9.15	0.65	0.42	0.62	0.85	1.17
11.....	7.65	7.40	7.00	7.70	7.77	7.43	8.60	0.60	0.47	0.57	0.92	1.08
12.....	8.38	7.22	7.87	7.83	7.55	7.70	8.03	0.60	0.50	0.50	1.03	0.98
13.....	9.57	7.15	7.73	7.93	8.05	7.77	7.50	0.53	0.55	0.57	1.03	0.92
14.....	10.35	7.83	7.90	8.05	8.28	7.90	6.90	0.45	0.50	0.63	1.04	0.90
15.....	10.65	7.15	7.80	8.20	8.18	9.87	6.63	0.40	0.50	0.67	1.01	0.90
16.....	10.83	7.20	7.57	8.32	7.77	10.47	6.70	0.40	0.48	0.88	1.22	0.90
17.....	10.48	7.05	7.80	8.45	7.45	9.92	6.67	0.40	0.45	1.10	1.22	0.93
18.....	10.13	6.83	7.52	8.63	7.40	9.52	6.40	0.37	0.45	1.27	1.22	0.93
19.....	10.10	6.75	7.47	8.73	7.40	9.10	5.98	0.30	0.50	1.35	1.10	0.87
20.....	10.25	6.93	7.52	8.83	7.40	9.05	5.55	0.25	0.55	1.40	1.15	0.87
21.....	10.37	6.92	7.62	8.92	7.35	9.10	5.02	0.32	0.60	1.40	1.15	0.90
22.....	10.47	6.78	7.60	9.08	7.28	9.12	4.52	0.45	0.62	1.40	1.22	0.90
23.....	10.45	6.60	7.48	9.12	7.22	9.22	4.15	0.70	0.65	1.40	1.80	0.85
24.....	10.20	6.50	7.43	9.18	7.33	9.35	3.95	0.75	0.65	1.33	1.35	0.85
25.....	9.95	6.62	7.38	9.23	7.35	9.50	3.60	0.55	0.65	1.23	1.40	0.90
26.....	9.83	6.90	7.83	9.42	7.28	9.62	3.20	0.47	0.60	1.15	1.45	1.12
27.....	9.78	7.25	7.40	9.93	7.12	9.75	2.90	0.45	0.58	1.15	1.50	1.00
28.....	9.68	7.28	8.28	10.13	7.02	9.92	2.58	0.45	0.55	1.20	1.50	0.95
29.....	9.62	.....	8.65	10.15	6.93	10.15	2.30	0.40	0.56	1.25	1.53	0.72
30.....	9.53	.....	8.78	9.98	6.83	10.40	2.05	0.33	0.50	1.32	1.55	0.58
31.....	9.40	.....	8.50	.....	6.75	.....	1.80	0.28	.....	1.40	.....	0.53
Mean	8.65	7.53	7.27	8.31	7.92	8.38	6.71	0.68	0.46	0.91	1.24	1.05

Gauge readings on the Illinois River at La Grange, Ill.

[Referred to lower miter sill, 7 feet below low water of 1879 and 14.4 below crest of dam.]

UPPER GAUGE, 1890.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>
1.....	18.80	17.78	18.06	15.85	15.15	15.23	15.47	15.73
2.....	18.77	17.78	18.06	15.77	15.15	15.25	15.47	15.72
3.....	18.63	17.75	18.09	15.54	15.13	15.20	15.42	15.63
4.....	18.55	17.73	18.07	15.48	15.12	15.22	15.47	15.62
5.....	18.50	17.68	17.93	15.44	15.15	15.25	15.43	15.63
6.....	18.43	17.59	17.87	15.40	15.07	15.20	15.42	15.60
7.....	18.28	17.56	17.83	15.46	15.10	15.23	15.50	15.60
8.....	18.18	17.68	17.77	15.34	15.07	15.20	15.57	15.48
9.....	18.08	17.58	17.73	15.29	15.28	15.25	15.67	15.46
10.....	18.02	17.68	17.62	15.24	15.30	15.30	15.55	15.35
11.....	17.98	17.51	17.53	15.25	15.25	15.25	15.55	15.37
12.....	17.95	17.48	17.43	15.23	15.20	15.25	15.50	15.45
13.....	17.99	17.46	17.37	15.19	15.28	15.22	15.47	15.40
14.....	17.98	17.48	17.25	15.19	15.25	15.33	15.62	15.38
15.....	17.90	18.25	17.53	15.20	15.25	15.67	15.68	15.42
16.....	17.86	18.05	17.52	15.22	15.30	15.67	15.60	15.45
17.....	17.80	17.90	17.43	15.20	15.32	15.68	15.55	15.47
18.....	17.88	17.79	17.32	15.20	15.30	15.52	15.62	15.50
19.....	17.90	17.82	17.20	15.15	15.38	15.58	15.68	15.50
20.....	17.90	17.83	17.03	15.15	15.35	15.55	15.67	15.50
21.....	17.90	17.80	16.87	15.38	15.50	15.55	15.70	15.50
22.....	17.90	17.82	16.72	15.35	15.50	15.50	15.70	15.45
23.....	17.93	17.85	17.45	15.27	15.32	15.50	15.62	15.45
24.....	17.90	17.83	16.35	15.25	15.33	15.60	15.68	15.43
25.....	17.90	17.79	16.26	15.20	15.32	15.60	15.70	15.40
26.....	17.88	17.94	16.10	15.25	15.25	15.60	15.73	15.40
27.....	17.78	17.98	16.02	15.20	15.30	15.55	15.70	15.40
28.....	17.78	17.95	15.84	15.20	15.20	15.58	15.70	15.40
29.....	17.72	18.01	15.71	15.20	15.25	15.50	15.67	15.37
30.....	17.75	18.05	15.85	15.20	15.22	15.55	15.70	15.35
31.....	17.70	.....	15.83	15.20	.....	15.55	.....	.....
Mean	17.39	17.78	17.12	15.30	15.25	15.42	15.58	15.48

Gauge readings on the Illinois River, at La Grange, Ill.

LOWER GAUGE, 1880.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.	13.40	18.45	15.58	16.73	17.87	15.68	16.40	9.40	7.95	8.08	8.55	8.41
2.	13.32	18.25	15.50	16.67	17.77	15.85	16.40	9.40	7.90	8.03	8.45	8.41
3.	13.26	18.08	15.43	16.60	17.60	15.85	16.37	9.28	7.87	8.07	8.38	8.41
4.	13.20	17.85	15.28	16.73	17.42	15.63	16.27	9.10	7.87	8.10	8.43	8.41
5.	13.28	17.65	15.18	16.83	17.27	15.58	16.18	8.88	7.89	8.03	8.52	8.41
6.	13.38	17.48	15.10	16.83	17.05	15.50	16.07	8.76	7.85	8.00	8.50	8.41
7.	13.63	17.32	15.10	16.80	16.94	15.48	16.05	8.68	7.88	8.00	8.48	8.41
8.	13.75	17.08	15.02	16.88	16.82	15.38	15.90	8.59	7.95	8.02	8.63	8.41
9.	14.18	16.93	14.92	16.90	16.62	15.40	15.70	8.47	8.15	8.02	8.62	8.41
10.	14.70	16.77	15.05	16.85	16.45	15.38	15.50	8.40	8.28	8.06	8.60	8.41
11.	15.35	16.62	15.30	16.98	16.22	15.28	15.23	8.35	8.20	8.00	8.65	8.41
12.	16.45	16.44	15.92	17.08	16.08	15.10	14.95	8.30	8.12	8.03	8.73	8.41
13.	17.70	16.33	16.25	17.18	16.18	15.08	14.75	8.15	8.18	8.23	8.70	8.41
14.	18.31	16.23	16.12	17.34	16.25	15.08	14.53	8.00	8.12	8.32	8.70	8.41
15.	18.73	16.08	15.98	17.39	16.15	15.80	14.85	8.00	8.06	8.05	8.75	8.41
16.	19.00	15.93	15.87	17.42	16.02	16.95	14.98	8.03	8.12	8.28	8.53	8.41
17.	19.40	15.76	15.87	17.56	15.95	16.60	14.95	8.05	8.14	8.20	8.50	8.41
18.	19.81	15.63	15.95	17.61	15.98	16.20	14.60	8.00	8.12	8.08	8.50	8.41
19.	19.83	15.53	16.10	17.70	16.00	16.03	14.30	7.95	8.20	8.97	8.50	8.41
20.	20.00	15.38	16.22	17.82	16.07	15.97	13.85	7.95	8.23	9.10	8.55	8.41
21.	20.18	15.36	16.35	17.87	16.05	15.81	13.35	8.43	8.28	9.05	8.95	8.41
22.	19.80	15.39	16.40	17.96	16.08	15.90	12.85	8.60	8.19	9.02	8.95	8.41
23.	19.73	15.43	16.40	18.02	16.05	15.88	12.28	8.43	8.20	8.88	9.03	8.41
24.	19.65	15.40	16.40	18.10	16.00	15.90	11.65	8.30	8.85	8.80	9.12	8.41
25.	19.53	15.45	16.32	18.10	16.00	15.92	11.09	8.27	8.93	8.85	9.35	8.41
26.	19.40	15.53	16.17	18.20	15.97	15.88	10.73	8.20	8.22	8.85	9.42	8.41
27.	19.28	15.63	16.25	18.32	15.85	16.08	10.40	8.15	8.25	8.78	9.45	8.41
28.	19.15	15.65	16.70	18.27	15.75	16.13	10.10	8.05	8.22	8.83	9.45	8.41
29.	18.98	.....	17.05	18.17	15.72	16.23	9.77	7.85	8.20	8.72	9.43	8.41
30.	18.70	.....	16.97	18.05	15.72	16.32	9.47	7.85	8.13	8.90	9.40	8.41
31.	18.65	.....	16.82	.....	15.70	.....	9.38	7.95	.....	8.72	.....	8.41
Mean	17.22	16.41	15.92	17.43	16.39	15.83	13.83	8.39	8.11	8.58	8.86	8.41

Gauge readings on the Illinois River above Copperas Creek Lock.

[Referred to the top of the lower miter still.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>
1.	18.20	20.60	18.83	20.55	21.00	20.83	21.72	17.05	16.70	16.72	17.10	17.10
2.	18.20	20.60	18.80	20.63	20.92	20.93	21.60	17.05	16.70	16.75	17.10	17.10
3.	18.20	20.47	18.80	20.70	20.85	20.98	21.45	17.00	16.70	16.80	17.10	17.10
4.	18.15	20.40	18.73	20.70	20.75	20.90	21.20	16.90	16.70	16.80	17.10	17.10
5.	18.18	20.30	18.62	20.80	20.72	20.82	20.93	16.90	16.70	16.80	17.07	17.10
6.	18.28	20.00	18.60	20.85	20.62	20.75	20.85	16.90	16.70	16.80	17.05	17.10
7.	18.45	20.00	18.60	20.90	20.52	20.62	20.60	16.90	16.65	16.80	17.05	17.10
8.	18.60	20.00	18.42	20.90	20.35	20.55	20.85	16.90	16.57	11.80	17.00	17.10
9.	18.73	20.00	18.25	21.05	20.15	20.40	20.15	16.85	16.70	16.80	17.00	17.10
10.	18.92	19.90	18.13	21.23	20.00	20.25	19.92	16.80	16.70	16.85	17.00	17.10
11.	19.20	19.80	18.40	21.45	20.00	20.10	19.80	16.80	16.65	16.85	17.03	17.10
12.	19.50	19.70	18.70	21.62	19.92	19.95	19.72	16.80	16.70	16.85	17.07	17.10
13.	19.80	18.70	18.95	21.77	19.82	19.85	19.62	16.80	16.70	17.07	17.10	17.10
14.	20.10	19.57	19.20	21.85	19.80	19.85	19.62	16.80	16.70	17.13	17.10	17.10
15.	20.33	19.48	19.43	21.90	19.90	19.70	19.38	16.80	16.70	17.15	17.10	17.10
16.	20.80	19.32	19.63	21.97	20.00	19.70	19.80	16.80	16.72	17.15	17.15	17.10
17.	21.33	19.30	19.67	22.15	20.20	19.80	19.15	16.80	16.75	17.20	17.15	17.10
18.	21.57	19.30	19.70	22.28	20.00	20.02	18.92	16.80	16.80	17.20	17.20	17.10
19.	21.70	19.28	19.77	22.30	20.15	20.33	18.75	16.80	16.80	17.20	17.20	17.10
20.	21.70	19.23	19.80	22.30	20.20	20.48	18.55	16.80	16.80	17.20	17.22	17.10
21.	21.82	19.15	19.90	22.22	20.25	20.65	18.40	16.80	16.85	17.22	17.30	17.10
22.	21.88	19.03	19.90	22.10	20.25	20.77	18.20	16.80	16.85	17.20	17.30	17.10
23.	21.95	19.00	19.90	21.97	20.28	20.88	17.90	16.80	16.80	17.20	17.30	17.10
24.	22.00	19.00	19.90	21.80	20.30	21.08	17.50	16.80	16.80	17.20	17.30	17.10
25.	21.85	19.00	19.95	21.70	20.30	21.33	17.15	16.75	16.80	17.20	17.30	17.10
26.	21.70	18.95	20.00	21.60	20.38	21.58	17.20	16.70	16.80	17.20	17.30	17.10
27.	21.60	18.95	20.10	21.60	20.48	21.83	17.18	16.70	16.80	17.20	17.30	17.10
28.	21.40	18.92	20.15	21.50	20.60	22.02	17.07	16.68	16.80	17.20	17.30	17.10
29.	21.13	.....	20.20	21.38	20.67	22.00	17.10	16.70	16.80	17.15	17.30	17.10
30.	20.97	.....	20.35	21.18	20.78	21.88	17.05	16.70	16.80	17.10	17.30	17.10
31.	20.80	.....	20.45	.....	20.80	.....	17.05	16.70	.....	17.10	.....	17.10
Mean	20.22	19.60	19.35	21.50	20.35	20.70	19.14	16.82	16.74	17.08	17.16	17.10

Gauge readings on the Illinois River below Copperas Creek Lock, 1889.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	16.90	20.70	18.43	20.22	20.50	20.40	21.52	14.92	12.50	12.65	13.38	13.80
2	16.88	20.48	18.40	20.30	20.70	20.53	21.32	14.85	12.50	12.65	13.30	13.30
3	16.77	20.33	18.37	20.30	20.63	20.60	21.10	14.75	12.50	12.70	13.27	13.80
4	16.70	20.18	18.30	20.25	20.57	20.50	20.80	14.53	12.50	12.75	13.20	13.88
5	16.27	20.10	18.25	20.30	20.50	20.43	20.53	14.33	12.45	12.75	13.20	13.80
6	16.45	20.00	18.20	20.40	20.45	20.33	20.44	14.03	12.43	12.80	13.15	18.72
7	16.80	19.95	18.50	20.45	20.35	20.30	20.20	13.87	12.40	12.80	13.12	13.70
8	17.23	19.87	17.97	20.65	20.10	20.27	19.94	13.63	12.43	12.75	13.10	13.62
9	17.70	19.72	17.75	20.85	19.90	20.20	19.75	13.43	12.63	12.78	13.08	13.60
10	18.10	19.60	17.70	21.03	19.73	20.10	19.40	13.25	12.60	12.80	13.00	13.50
11	18.57	19.50	18.20	21.22	19.70	20.02	19.10	13.13	12.60	12.80	13.00	13.50
12	19.12	19.40	18.40	21.33	19.67	19.88	18.80	13.00	12.60	12.80	13.00	13.42
13	19.65	19.30	18.58	21.40	19.60	19.78	18.53	12.92	12.60	13.25	13.08	13.33
14	19.72	19.20	18.90	21.48	19.52	19.67	18.43	12.82	12.60	13.30	13.08	13.30
15	19.93	19.12	19.10	21.60	19.60	19.50	18.30	12.80	12.67	13.35	13.10	13.80
16	20.38	19.02	19.17	21.72	19.68	19.50	18.13	12.77	12.75	13.40	13.10	13.35
17	20.77	18.95	19.23	21.85	19.70	19.57	17.87	12.70	12.80	13.40	13.18	12.40
18	21.07	18.90	19.35	22.03	19.73	19.67	17.00	12.62	12.80	13.40	13.22	13.40
19	21.25	18.85	19.40	22.10	19.88	19.90	16.53	12.60	12.85	13.40	13.85	13.40
20	21.40	18.82	19.45	22.10	19.90	20.12	16.35	12.66	12.85	13.40	13.40	13.40
21	21.54	18.75	19.50	22.05	19.98	20.35	16.05	12.65	12.87	13.42	13.48	13.40
22	21.60	18.65	19.50	21.93	20.00	20.45	15.90	12.70	12.90	13.50	13.50	13.40
23	21.62	18.60	19.55	21.78	20.00	20.72	15.85	12.62	12.85	13.50	13.50	13.40
24	21.70	18.65	19.60	21.70	20.00	21.00	15.55	12.60	12.80	13.50	13.57	13.42
25	21.57	18.65	19.60	21.62	20.00	21.30	15.40	12.60	12.80	13.50	13.60	13.40
26	21.45	18.60	19.60	21.50	20.07	21.62	15.40	12.60	12.80	13.50	13.63	13.48
27	21.37	18.53	19.73	21.50	20.25	21.73	15.30	12.60	12.80	13.45	13.70	13.50
28	21.20	18.50	19.83	21.28	20.35	21.90	15.18	12.60	12.73	13.40	13.70	13.50
29	21.03	19.95	19.25	20.40	21.90	15.07	12.60	12.68	12.68	13.40	13.75	13.58
30	20.87	20.00	21.08	20.40	21.75	15.00	12.60	12.65	12.65	13.40	13.80	13.60
31	20.80	20.05	20.40	20.40	20.40	14.95	12.55	12.55	12.55	13.40	13.80	13.60
Mean	19.56	19.31	18.98	21.24	20.07	20.46	17.86	13.17	12.66	13.16	13.32	13.52

PRELIMINARY REPORT OF W. E. WORTHEN, CHIEF ENGINEER, AND JOHN NEWTON, CONSULTING ENGINEER, TO BOARD OF TRUSTEES OF SANITARY DISTRICT OF CHICAGO, ON FEASIBLE ROUTES FOR DRAINAGE CHANNEL FROM CHICAGO TO JOLIET.

We have the honor to submit a preliminary report, with a map, showing certain feasible routes for the proposed drainage channel from Chicago to Joliet.

The dimensions of the drainage channel have been described by the act "to create sanitary districts and remove obstructions in the Desplaines and the Illinois Rivers," etc. (Section 208.)

This act provides that the drainage channel "shall be constructed of sufficient size and capacity to produce and maintain at all times a continuous flow of not less than 300,000 cubic feet of water per minute, and to be of a depth of not less than 14 feet, and a current not exceeding 3 miles per hour, and if any portion of any such channel shall be cut through a territory with a rocky stratum where such territory with rocky stratum is above a grade sufficient to produce a depth of water from Lake Michigan of not less than 18 feet, such portion of such channel shall have double the flowing capacity before provided for, and a width of not less than 160 feet at the bottom, capable of producing the depth of not less than 18 feet of water.

DESCRIPTION OF NEW ROUTES AND ESTIMATES.

Of all the new routes that have been surveyed, plotted, profiled, cross-sectioned, and estimated, two only have been selected for comparison—those marked on plan in full lines, the Ogden ditch line and the line "D." We think the former to be the better, as it is somewhat less expensive, and it provides at the same time for carrying off the storm water of the Upper Desplaines without the necessity of constructing expensive cut-offs from the Desplaines to the lake north of Chicago. In this view the channels estimated and designed for the maximum flow of 600,000 cubic feet per minute will suffice, and with the gate cut-off in the Ogden ditch line, somewhere in the west fork of South Branch, will prevent the high water of the Desplaines flowing back into the Chicago River.

APPROXIMATE ESTIMATE.

We estimate the total cost of entire line of 18 feet water depth by way of Ogden ditch at \$25,700,000.

If the excavation in earth be reduced to 14 feet water depth and the side rubble walls be omitted, we estimate the cost at \$22,700,000.

If the difference between 14 feet and the maximum depth provided by law is to be taken out it could be much more cheaply done when the channel is dry than by dredging after the water has been let in. Most of the work in the excavation and transfer of material must be done by machinery, and under a thorough system with the best modern appliances, ample space for the piling up of waste, and removal by rail, the channel should be completed in 4 years.

Between Bridgeport and Willow Springs there will be 17,526,000 cubic yards of waste material if the water depth is 18 feet, and 14,656,000 if the water depth is 14 feet.

Between Willow Springs and the Joliet Basin there will be 3,500,000 cubic yards of earth excavation, 3,537,000 cubic yards of hardpan excavation, and 13,361,830 cubic yards of rock excavation.

Between Willow Springs and the Joliet Basin there will be 18,948,600 cubic yards of waste material, of which 13,361,830 cubic yards are rock.

How far earth and rock may be found to be of marketable or other value we leave to experts; but it would seem that the rock has already a market, and it could be stored on the banks while waiting disposal.

The dimensions of the section of the channel are shown in the drawing, being an average width of 180 feet, with nearly vertical sides, and the depth of 18 feet below the flow line of water.

A route following the line of the canal is feasible, but it must be considered that the canal is already a part of a drainage system, and can not at present be dispensed with. To attempt to convert it, while thus used, into the main channel of the new system would be attended with great difficulty and cost.

Although not urgently required until the completion of the system, we have considered it expedient at this time, with the view of eventually securing an ample supply of lake water, to call attention to the necessity of straightening, widening, and dredging in certain places the Chicago River and its branches, and of increasing the discharge of the pumps at Fullerton avenue. That discharge now averages 12,000 feet per minute, and it should be increased to 30,000 at the lowest. Provision must be made also for conveying a supply of fresh water into the east and west arms of the south fork, and for carrying off the diluted contents.

The law provides for the new drainage channel to terminate at the upper basin at Joliet. The addition of 300,000 cubic feet per minute, the usual estimated flow of the channel, will drown out Locks 5 and 6. Consequently some adequate means must be devised to dispose of the discharge of the channel at that place, so that property, persons, and health in the Illinois River Valley shall not be endangered.

From the termination of the channel at Joliet to a point above the Snag, rock excavation could be advertised as soon as the title to the lands is secured. It is proposed, first, to cut a longitudinal trench—a part of the channel—through the route in that portion of the route just described. The trench thus executed will save much in pumping and in plant, and its completion will constitute an important progress in the execution of the whole system. In fact, to effect the drainage of the whole work during the progress of excavation, the lower portion, toward Joliet, would naturally be first undertaken.

W. E. WORTHEN,
Chief Engineer.
JOHN NEWTON,
Consulting Engineer.

To the honorable BOARD OF TRUSTEES OF THE SANITARY DISTRICT OF CHICAGO.

JANUARY 13, 1891.

REPORT OF W. E. WORTHEN, CHIEF ENGINEER, AND JOHN NEWTON, CONSULTING ENGINEER, TO BOARD OF TRUSTEES OF CHICAGO SANITARY DISTRICT, ON LOCATION OF DRAINAGE CHANNEL BETWEEN JOLIET AND SUMMIT.

FEBRUARY 21, 1891

We have the honor to submit the following report:

In our preliminary report of January 13 last, the line of the drainage channel with dimensions of its cross sections, as prescribed by the provisions of the act creating the sanitary district of Chicago, was submitted to the board of trustees.

ROUTE OF PROPOSED DRAINAGE CHANNEL LAID OUT.

Since that report and agreeably to the instructions of the board to the chief engineer "to locate a route pursuant to his report, on the ground between Joliet and the boundary of the district near the Summit, so as to enable the board to make

al location of the route between those points; and that the attorney of the board prepare the proper petition to enable the board to begin condemnation proceedings, secure the right of way over the route," the said route has been laid out, and a description of the lands to be taken for the construction of the drainage channel, together with plats of the same, has been furnished to the attorney of the board.

NEW ESTIMATE OF EXCAVATION OF PROPOSED DRAINAGE CHANNEL TO BE MADE.

For the purpose of a more thorough estimate of the quantities of material to be excavated from the proposed drainage channel, additional cross sections along the line with borings have been undertaken and are now nearly completed. So far as can be judged, a new estimate will not exceed that of the preliminary report.

PROVISION FOR THE DISCHARGE OF THE DRAINAGE CHANNEL AT JOLIET AND FOR THE CREATION OF WATER POWER.

Extract from preliminary report of January 13 last:

"The law provides for the new drainage channel to terminate at the upper basin at Joliet. The addition of 300,000 cubic feet per minute, the usual estimated flow of the channel, will drown out Locks 5 and 6. Consequently some adequate means must be devised to dispose of the discharge of the channel at that place, so that property, persons, and health in the Illinois River Valley shall not be endangered."

Surveys and contoured maps of portions of the city of Joliet on each side of the river have been made for the study of the prolongation of the water way below that city, with the conditions imposed of avoiding flooding the Upper Joliet Basin and drowning out Locks 5 and 6, and of securing at the same time more fall for the incidental water power created, which, under section 192 of the drainage act, the board of trustees is empowered "to control and dispose of."

Some of the results above mentioned can be secured by the construction of a tunnel channel under Joliet, or by the laying of a wrought-iron pipe, 24 feet in diameter, along the banks of the river to some desirable locality below the city of Joliet. Surveys have demonstrated that either a tunnel or an iron-pipe extension is entirely practicable, and that if the pipe be adopted, that either side of the river may be used for the erection of wheels. If the flow through the channel is 300,000 cubic feet per minute, with the net fall at this place of some 46 feet, the power obtained will equal 0,000 net horse-power, allowance being made for lockage, and the total cost will be small in comparison with the value of results.

The engines of paper mills usually run the full 24 hours for 6 days in the week, but most of the manufactories run but 10 hours per day at the maximum, and less on the average. The power here supplied is continuous, however, and if it were transferred by electric currents to the city of Chicago, it could be used for various purposes, such as lighting, or for power applied to pumping sewage, etc.

It is contemplated, if the United States should adopt the drainage channel as a part of the navigation system between the Illinois River and Lake Michigan, that they will construct a lock of suitable dimensions, as a means of communication from the drainage channel to the upper basin at Joliet.

REASONS FOR THE CHOICE OF ROUTE FOR THE DRAINAGE PROPOSED IN THE PRELIMINARY REPORT.

The possibilities of the Illinois and Michigan Canal as the line of the principal drainage channel were investigated before recommending any route. The difficulties of non-interference with the "public use" during the time—say 4 years—occupied in the enlargement and deepening of the canal necessary for its conversion into the drainage channel, the extra cost of rock excavation, if this be carried on while the canal is kept in "public use" and used also for the transport of sewage, were seriously considered.

The large cross section that the law demands for the western portion of the drainage channel—which is in rock—made it expedient to adopt the recommended route, which would likewise serve for the diversion of the Upper Desplaines. Since that report we have more fully considered the plans of Mr. Hering for the diversion of the Upper Desplaines, first into the north branch and then into the lake by a channel at Bowmanville, and we have made a personal examination of the locality.

In Mr. Hering's report of July 1, 1887, to the mayor and common council upon his project for the diversion of the Upper Desplaines, he states: "At Summit the drainage area, including that of Salt Creek, will be 194 square miles, and the quantity of water will not differ much from that which now flows, during floods, toward Joliet," and he estimates that even after the completion of his scheme for the diversion, that

from 4,000 to 5,000 cubic feet per second during floods will not be intercepted, as before, will flow down the Desplaines.

Our conclusion is in confirmation of our previous recommendation on this subject submitted to the board, viz, that the portion of the drainage channel beyond Summit be used as the diversion of the Upper Desplaines. In this connection it can be seen by the records of the flood, which culminated on February 9, 1887, with a volume of 10,324 cubic feet per second, that it fell on the 10th to 8,000 cubic feet, the 11th to 7,000, and on the 16th to 2,000, rising again on the 19th to 5,174 cubic feet. The effect of the outflow from this flood through the Chicago River into the lake is shown by the sketch of Mr. Hering. It does not appear to have reached the lake and contaminated the water supply, except at the period of maximum flood of 103 cubic feet per second. After the construction of the proposed new drainage channel, comparatively little water from such a flood would find its way into the river, even for a brief period, if the gates (which it is proposed to place in the new drainage channel) were left open. Ten thousand cubic feet per second is to be provided for in the new channel, when the system contemplated by the present law is completed, and the floods in the Upper Desplaines exceeding this quantity are exceedingly rare.

The great facilities of discharge of floods through the new channel into the Desplaines, compared with those existing at present, if duly weighed and brought into calculation, indicate that the time of stagnation of sewage in the river would be brief. Finally, the Illinois Canal, in the altered condition recommended further in this paper, would probably prove sufficient during a flood of the magnitude called above, and even unassisted by the new drainage channel and the diversion of the upper Desplaines, to prevent a pollution of the water supply.

PLAN FOR THE INCREASE OF FLOW FROM THE RIVER THROUGH THE SOUTH BRANCH AND WEST FORK TO BRIDGEPORT.

Lines are laid down in the sketch accompanying this paper to indicate the modifications necessary between Bridgeport and the river through the West Fork and South Branch, to secure a uniform width of 160 feet and central depth of 15 feet, thus effecting an amelioration of navigation and greater facilities for the dilution of sewage by the increase of flow from the lake.

DISPOSAL OF SEWAGE FROM STOCK YARDS.

It seems to us imperative that all the drainage of the stock yards and packing houses should be kept out of the east and west arm of the South Fork. Otherwise from the size of the cross sections of those arms, an introduction of fresh water from the lake, larger than could be removed by the Illinois Canal, must be induced to prevent stagnation.

For the introduction of a sufficient amount of fresh water from the lake into the arms the slight difference of level would enforce the construction of a water way (either a conduit or open cut) of large and costly dimensions if gravity flow alone be used. Pumping would therefore be a necessity to increase the head, and consequently diminish the cross section and cost. However, the value of real estate along the line of supply would preclude the idea of the open cut and make the adoption of the conduit preferable whenever in the future the growth of the city would make connection with the lake at this place a necessity.

It is therefore judged expedient to recommend that an intercepting sewer from Halstead street along the northerly line of the packing houses be constructed of capacity equal to the maximum flow—38 cubic feet per second—of these establishments, and that it be extended to the extremity of the west arm, and here a pumping station, with a pump of the capacity of discharge of 700 cubic feet per second be located, drawing both from the west arm and the intercepting sewer, and discharging the united discharge into a sewer or open cut leading through Thirty-ninth street to the Illinois Canal. By this means the flow from the packing houses will be kept from stagnating and becoming offensive, and will be diluted to a greater degree of purity than that already flowing into the canal. This flow will not average more than 10 hours per day.

We make no estimate of this work, for the reason that it seems to us the expense should be borne by the private establishments which contribute so largely to the nuisance to be abated, and by the city also, which intends to and must make use of it as an important part of the sewerage system.

MODIFICATION OF THE ILLINOIS AND MICHIGAN CANAL.

After considerable deliberation of the question whether to continue the pumping station at Bridgeport or to effect the transport of sewage along the canal by gravity alone, it is recommended to adopt the latter plan. Even if the former plan were

ained it would still become necessary, in view of increasing the flow, to deepen a canal in order to obtain the necessary cross section for the transport of sewage. The plan by gravitation involves sinking the bottom of the canal as far as the first lock, lowering the water surface about $5\frac{1}{2}$ feet, with the modification of that lock altered necessary by this change, increasing the cross section and discharge, and avoiding an overflow.

The discharge into the canal will be, according to the fluctuation of the lake, from 400 to 1,500 cubic feet per second, or 72,000 to 90,000 cubic feet per minute.

Estimate of cost of rock and earth excavation and of change of lock at Bridgeport and Lock No. 1 at Lockport, \$3,200,000.

In addition, but the cost not estimated, there must be some changes in the application of water-power at Norton & Co.'s mills, on the canal at Lockport, on account of the lowering of the head of water.

We have expressed our preference for the above scheme of making the flow in the canal by gravitation, but we have also estimated the cost of excavation for a larger capacity of flow in the canal by pumps, preserving the present level nearly, but never exceeding it, and reducing the lift at Bridgeport to increase the discharge of the pumps. All excavation done under this scheme is so much towards that necessary for the flow by gravitation.

Estimated cost of increasing the section of the Illinois Canal and maintaining an increased flow by pumping, \$1,800,000.

Extract from official report of Bridgeport pumping works.

Year.	Total operating expenses.
85	\$44,644.07
86	40,973.40
87	43,698.92
88	39,618.91
89 (9 months)	74,305.02

[In 1889 there were complete repairs of all the pumps.]

The above table represents the yearly cost of the Bridgeport pumps, which it is proposed to change in the pumping scheme.

FULLERTON AVENUE PUMPING STATION AND BOWMANVILLE.

In our previous report we recommended the increasing of the discharge of the Fullerton Avenue pumps, but it is doubtful if this could be effected without the substitution of other pumps, and as by the report of the commissioner of public works the duty of those pumps is very small, it would be economy to supply new pumps of increased capacity. Accordingly, as the change is necessary, we would commend that the new pumps be placed at Bowmanville instead of at Fullerton Avenue, for the reason that the North Branch, as the area of dwellings extend northwards, is progressively the receptacle of sewage, and it becomes therefore more and more necessary also to shift the pumping and flushing station northwards.

The communication with the lake at Bowmanville to supply water for flushing might preferably be by a conduit instead of by a cut.

The cost of water connection between the lake at Bowmanville and the North Branch of the Chicago River has been estimated on the basis of the construction of 16-foot brick conduit, with a pumping engine similar to the sewage engine at Milwaukee, with boilers, engine rooms, water gates, etc., at the lake, all complete and working order.

Estimate.

conduit	\$900,000
pumping engine, house, etc	70,000

It has not been considered necessary at present to estimate for a duplicate engine, the one at Fullerton Avenue might answer temporarily during the repairs of the one at Bowmanville. The flow through an open cut, as proposed by Mr. Hering, could be at times by gravity, but there would be a necessity of some pumping engine to make this current sufficiently permanent to act as a flush on the North Branch.

[NOTE.—The main drainage channel has been decided by the drainage law to have a capacity of 600,000 cubic feet per minute, but not actually to carry more than 300,000 cubic feet, unless the United States should first guarantee the

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sanitary district against damages along the Desplaines and Illinois rivers, and from the additional amount of water.

No provision has been decided to provide more than about 300,000 cubic feet of the channel, nor is there any apparent necessity therefor, until the conditions needed to the discharge of 600,000 cubic feet shall have been fulfilled by the Government.]

SYNOPSIS OF SUBJECTS TREATED IN THIS REPORT.

(1) The drainage channel has been laid out between Joliet and the Summit, description of the lands to be taken for the construction of that portion of the drainage channel, together with plats of the same, has been furnished to the attorney of the board.

(2) A new estimate of cost of the drainage channel will soon be prepared.

(3) Provision is made for the discharge of the drainage channel at Joliet and the incidental creation of water-powers.

(4) Reasons are given for the choice of route for the drainage channel proposed in the preliminary report. The large estimated cost of this channel is due to the depths which the drainage act prescribes. The capacity of the proposed channel and its great cost therefore enforces, in order to save further expense, the choice of it for the diversion of the upper Desplaines.

(5) Plan for the increase of flow through the South Branch and West Branch at Bridgeport.

(6) Disposal of sewage from the stock yards and packing houses.

(7) Modification of the Illinois and Michigan Canal and its use as an auxiliary to the drainage system.

(8) Pumping station at Fullerton avenue and Bowmanville.

In the reports rendered by the engineers, they have treated the subject of drainage as broadly and as fully as the scope of the legislative act extended: they have prescribed the route and dimensions of the principal drainage channels, drainage of the stock yards and packing houses and of the east and west arms of drainage of the North Branch, the diversion of the upper Desplaines, and the addition of the Illinois and Michigan Canal within the limits of Cook County to the disposal of an auxiliary drain discharging eventually into the main drainage channel.

Estimates have been made for all independent work pertaining to the board of trustees alone, but in several cases where the cost of construction or of modification of existing structures belonged equitably to private parties or to the city of Chicago, no estimate has been made.

A revised estimate will be made of the excavation of the principal drainage channel as soon as all the measurements are completed.

No estimate of land damages has been made, as this is clearly beyond the scope of engineering duties.

W. E. WORTHEN,
Chief Engineer
JOHN NEWTON,
Consulting Engineer

The honorable BOARD OF TRUSTEES OF THE SANITARY DISTRICT OF CHICAGO

REPORT OF SAMUEL G. ARTINGSTALL, CHIEF ENGINEER, TO BOARD OF TRUSTEES OF THE SANITARY DISTRICT OF CHICAGO, ON RESULTS OF CHEMICAL ANALYSIS OF SEWAGE TAKEN FROM CHICAGO RIVER AND BRANCHES.

GENTLEMEN: Herewith find the mean results of 133 samples of sewage taken from the Chicago River and its branches and analyzed by Prof. J. H. Long. The original reports of each sample are in the possession of this department.

Yours respectfully,

SAMUEL G. ARTINGSTALL,
Chief Engineer

The honorable BOARD OF TRUSTEES OF THE SANITARY DISTRICT OF CHICAGO

MAY 20, 1891.

Means of analyses of sewage samples (results given in parts per million).

[By Prof. J. H. Long.]

	Number of sam- ples.	Temperature of samples (cen- tigrade).	Total solids in whole.	Fixed solids in whole.	Volatile and or- ganic.	Total solids in solution.	Fixed solids in solution.
Halstead street and Thirty-ninth, Nov. 5 to 25, 1890	21	10.04°	973.0	694.9	278.1	815.4	628.6
Halstead street and Thirty-ninth, storm water, Nov. 16, 1890	1		782	588	194	674	566
Ashland avenue and Brennock sewers, Dec. 5 to 30, inclusive, 1890	24	17.7°	6,473.7	4,048.0	2,427.7	5,581.3	3,860.3
I. and M. Canal at Bridgeport, Oct. 16 to Dec. 30, inclusive, 1890	76	8.6°	493.2	301.7	191.5	383.2	320.5
Main street, South Branch, Dec. 26 to 29, 1890	3		320.7	236.0	84.7	287.3	218.7
Thirty-fifth street and South Fork, Nov. 29, 1890	1		2,304	2,092	30.2	2,258	2,008
Twenty-second street and South Branch, Nov. 29, 1890	1		398	344	54	236	200
Polk Street Bridge, South Branch, Nov. 28, 1890	1		360	290	74	268	214
Madison Street Bridge, South Branch, Nov. 28, 1890	1		272	226	46	216	170
Kinzie Street Bridge, North Branch, Nov. 27, 1890	1		342	276	66	254	198
Goose Island, North Branch, Nov. 27, 1890	1		294	226	68	244	206
Fullerton Avenue Bridge, North Branch, Nov. 26, 1890	1		216	188	28	174	146
Clybourn Place Bridge, North Branch, Nov. 26, 1890	1		226	190	36	216	186

	Volatile and or- ganic.	Solids in sus- pension.	Total nitrogen (Kjeldahl).	Total nitrogen as ammonia.	Free ammonia in filtrate.	Albuminoid am- monia in filtrate.	Oxygen con- sumed in filtrate.	Chlorine in fil- trate.
Halstead street and Thirty-ninth, Nov. 5 to 25, 1890	186	157.6	30.6	37.2	14.6	5.0	72.6	108.0
Halstead street and Thirty-ninth, storm water, Nov. 16, 1890	108	108	42.0	51.0	20.8	2.1	38.7	116.1
Ashland avenue and Brennock sewers, Dec. 5 to 30, inclusive, 1890	1,721.0	894.4	327.4	418.5	81.7	112.7	428.8	1894.8
I. and M. Canal at Bridgeport, Oct. 16 to Dec. 30, inclusive, 1890	167.7	105.0	18.01	21.85	13.17	1.65	20.60	70.33
Main street, South Branch, Dec. 26 to 29, 1890	68.6	33.3	11.39	13.83	15.68	2.59	14.85	25.25
Thirty-fifth street and South Fork, Nov. 29, 1890	250	136	157.92	191.76	152.00	6.20	70.40	916.15
Twenty-second street and South Branch, Nov. 29, 1890	36	162	6.44	7.82	2.56	0.96	11.52	16.28
Polk Street Bridge, South Branch, Nov. 28, 1890	54	92	7.56	9.18	2.88	1.28	11.12	18.01
Madison Street Bridge, South Branch, Nov. 28, 1890	46	56	5.04	6.12	2.94	1.10	7.68	14.51
Kinzie Street Bridge, North Branch, Nov. 27, 1890	56	88	6.16	7.58	2.40	1.68	10.88	18.40
Goose Island, North Branch, Nov. 27, 1890	38	50	5.04	6.12	1.92	1.04	11.52	14.33
Fullerton Avenue Bridge, North Branch, Nov. 26, 1890	28	42	2.52	3.06	1.44	0.67	2.24	5.66
Clybourn Place Bridge, North Branch, Nov. 26, 1890	30	10	3.64	4.42	2.18	1.56	2.72	8.67

REPORT OF SAMUEL G. ARTINGSTALL, CHIEF ENGINEER, TO BOARD OF TRUSTEES
CHICAGO SANITARY DISTRICT, ON FEASIBLE ROUTES FOR DRAINAGE CHANNEL
BETWEEN BRIDGEPORT AND SUMMIT.

I have the honor to submit the following report with map and estimates, showing four feasible routes for the main drainage channel between Bridgeport and Summit with comparative estimates of the cost of the same.

As the routes shown are wholly in earth excavation, the channels have been made of sufficient size and capacity to maintain at all times a continuous flow of not less than 300,000 cubic feet of water, and a depth of not less than 14 feet.

In making the estimates, wherever practicable the right of way is sufficient to provide for the deposit and storage of spoil during the construction of the work.

Four routes are considered.

First. Commencing in the West Fork of the South Branch at Western avenue, following the line of the Ogden Ditch to Summit.

Second. Commencing at the junction of the Illinois and Michigan Canal and South Fork of the Chicago River, and following the line of the canal to Summit.

Third. Commencing at the end of the west arm of the South Fork near Western avenue, thence westward along Thirty-ninth street to the Illinois and Michigan Canal, thence westerly along the canal to Summit.

Fourth. Follows the preceding route to the canal, where it crosses and continues in a northwesterly direction to the Ogden Ditch and along this ditch to Summit.

As it is imperative that the great pollution in the South Fork, caused mainly by the drainage of the stock yards and packing houses, should be provided for, and this can not be reached directly by routes 1 or 2, a smaller channel to provide a flow of 60,000 cubic feet per minute, commencing at the west end of the West Fork and discharging into the main channel, has been included in the estimates for the two routes.

Routes 3 and 4 I would respectfully recommend to your favorable consideration for the reason that the total volume of 300,000 cubic feet per minute will pass through the whole length of the South Branch and the West Fork of the South Branch, will insure a regular and constant circulation and change of water in the most polluted part of the stream, and this without any additional channels or pumping stations, with the attendant expense of maintenance and operation.

As the east arm of the South Fork is private property and not a natural channel it seems to me that the parties owning and using it should be at the expense of abating the nuisance.

The use of the Illinois and Michigan Canal, or any part of it, involves the removal of the present pumping station and locks at Bridgeport to a point west of the canal, where it occupies the line of the canal.

In my opinion no serious interruption to navigation or permanent injury will be done to the canal by the use of any portion of it as a part of the main channel.

I estimate the total cost of Channel No. 1 from Western avenue to Summit, by way of Ogden Ditch, at.....	\$2, 107.5
Channel No. 2, from river to Summit by way of Illinois and Michigan Canal, at.....	3, 367.5
Channel No. 3, from end of west arm of South Fork along Thirty-ninth street to canal, then by canal route to Summit, at.....	2, 688.5
Channel No. 4, following same route to canal, which it crosses, then in a northwestern direction to Ogden Ditch, then along the Ogden Ditch to Summit, at.....	2, 277.5

On account of the proximity of railroad track for a long distance on both banks of the canal, considerable of the excavated material, when the canal is enlarged to suitable size, will have to be removed by rail or vessel, and for this proper allowance has been made in the estimates.

It is not to be understood from the foregoing that there is recommended a prosecution of the work from Chicago to Summit only. On the contrary, so far as the means of the district would permit, there should be a line of operations on the east route simultaneously, or a beginning of the work at the lower end of the route at Joliet and working northwards.

The cost of right of way has not been made, as this department has not been directed to estimate this subject.

This department is now investigating in further detail the route for the continuation of the main channel from the Summit to Joliet, and will give you the results at the earliest possible time.

As soon as your honorable body can, after due deliberation, fix the route for a portion or the whole of length of the main channel, I wish to commence and prepare working drawings, specifications, etc., so as to be ready to commence operations at the time you have acquired the right of way.

At this time it may not be improper to state that I find in possession of this Board very valuable and reliable information and data, in the shape of contour maps and borings for the whole length of the route between Chicago and Joliet; also maps of the watersheds tributary to the Desplaines and Chicago rivers, measurements of the flow of the streams and analyses of the Chicago River water at various points, which are the results of the investigations carried on by your board up to this date. In addition to this is a large quantity of Government, city, and other data of considerable value.

The data obtained is now nearly all tabulated and in available form for immediate use.

The collection of this information has of necessity been a work of much time, care and labor, and was and is needed to arrive at an intelligent decision of the most economical and available route and sections of channel for this important work.

Respectfully submitted.

SAMUEL G. ARTINGSTALL,
Chief Engineer.

The honorable BOARD OF TRUSTEES OF THE SANITARY DISTRICT OF CHICAGO.

MAY 23, 1891.

REPORT OF SAMUEL G. ARTINGSTALL, CHIEF ENGINEER, TO BOARD OF TRUSTEES OF SANITARY DISTRICT OF CHICAGO, ON LOCATION OF DRAINAGE CHANNEL BETWEEN SUMMIT AND JOLIET.

GENTLEMEN: I have the honor to submit the following report, with estimates, being the result of investigations for the continuation of the main channel from Summit to Joliet. Much care and consideration has been given to locate this line so it can be constructed at the least cost and at the same time comply with all the requirements of the law in regard to dimensions, capacity, and velocity of water. The section from Summit to Willow Springs is located so as to avoid all expensive rock excavation. From Willow Springs to Lockport the route is laid out so that it occupies the lowest ground and generally follows the bed of the Desplaines River. This is a material advantage in the portion between Lemont and Lockport, where the whole depth of the channel is in hard limestone rock. From Lockport it is proposed to build the channel down the slope to the upper basin in Joliet "of sufficient width and depth to carry off the water the channel shall bring down from above." At the upper end of this slope is to be a movable dam to control and regulate the amount of water flowing in the channel above, and to guard against damage which is liable to occur in flood seasons to Joliet and below, unless means are taken to hold the water in check at such times.

There will also be a series of basins, weirs, and races in this section, which incidentally can be utilized for power, and in time be a source of revenue to the District.

To avoid as much as possible expensive limestone excavation, it is proposed to construct the channel below Lockport partly by removing obstructions, and partly by embankment of rubble masonry walls backed by the waste materials. Dikes will also have to be constructed to protect some of the low grounds from being flooded.

The proposed channel is almost entirely artificial, although in some parts it occupies the present bed of the Desplaines River and is subject to its floods, which will be under control by the movable dam at Lockport.

As that part of the route above Lockport for a length of nearly ten miles is almost wholly in rock, and the work of excavating any channel through it will be of necessity slow and tedious, work in this section can be commenced both at Lockport and at or near Willow Springs, and prosecuted as fast as the means at the disposal of the district will permit, while the less difficult stretches between Summit and Willow Springs, and between Lockport and Joliet, can proceed in such manner as to allow ample time to consider and carefully design suitable adjuncts necessary for the proper control of the waters when the channel is completed.

Between Summit and Joliet, a distance of 24½ miles, there will be 21,162,000 cubic yards of waste material, of which 8,303,383 cubic yards is rock excavation, and 12,858,617 cubic yards earth or glacial deposit.

This great quantity of spoil I consider of no marketable value at this time, and it is impracticable to dispose of it, except by depositing it on each side of the channel. A sufficient width of right of way will be necessary for this purpose.

I estimate the cost of constructing the channel as outlined above:

From Summit to west end of 14-foot channel near Willow Springs, at...	\$3,907,582
From west end of 14-foot channel to Lockport, at.....	9,031,973
From Lockport to Joliet, at.....	1,605,910

Total estimated cost 14,545,465

The cost of right of way is not included in the foregoing estimates. The spoil is to be deposited on the bank on each side of the channel, excepting a small portion of the rock, which can be used in building walls, dams, etc., below Lockport.

Respectfully submitted.

SAMUEL G. ARTINGSTALL,
Chief Engineer.

The honorable BOARD OF TRUSTEES OF THE SANITARY DISTRICT OF CHICAGO.
JUNE 20, 1891.

REPORT OF MR. W. M. CHILDS, ASSISTANT ENGINEER.

KAMPSVILLE, ILL., July 1, 1891.

SIR: I have the honor to submit the following report for improving Illinois River, for the year ending June 30, 1891:

LA GRANGE LOCK.

Material was purchased for building 2 pile revetments, each 240 feet long, one to be built above the lock, the other below and both to join the land-wall. The pile revetment below the lock was built during the months of October, November, and December, and is 307 feet long; 65 feet being a wing across the downstream end. The material used in this pile revetment is 107 oak piles, 292, 6 by 12 inch oak sheet piles, of the "Wakefield" patent, 614 linear feet of 6 by 12 inches and 307 linear feet of 2 by 12 inch oak wales, about 270 linear feet of 10 by 10 inch pine wales and 42 tie-rods. The anchor piles were driven 18 feet back from the face of the dike. The part of the dike where the wing joins the main dike was so far from the bank that when the soft filling material was cast back of the sheet piles by the dredge the sheet piles gave away slightly, taking the anchor piles with them. The "operating and care" force removed some of the filling along the sheet piles and pulled the dike back to its original position. About 275 linear feet of the old cofferdam were cut to pieces down to the 1½-foot stage; 70 tie-rods were removed and saved. Eave-gutters and conductor-spouts were put on the lock superintendent's house and a cistern of about 6,000 gallons capacity was built. A bank of 700 cubic yards of earth was put around the foundation of the lockhouse to protect the cellar.

LA GRANGE DAM.

During low water, the 170 linear feet of main dam that had to be left unfinished last year was filled with stone and coped with two thicknesses of 2-inch plank, 9,410 square feet; 30 feet more of the apron was coped with 4-inch oak. There are 310 feet of the main dam, near the middle of the river, with no apron below it. Four hundred and seventeen cubic yards of stone were put in the dam. A small strip of riprapping, 107 cubic yards, was placed against the sheet piling, on the filling above the dam. One thousand eight hundred and one cubic yards of riprapping were placed below the dam. Where there is no apron more stone was used and made to be of the same cross section as elsewhere below the dam. The coping and pile caps of the apron, over the downstream row of piles, had raised a little from the piles; where the coping and stringers were up they were drawn and hammered down and secured in place by long drift bolts driven slantingly through the coping and caps and into the piles. The corners, where the upper and lower pile revetments join the east abutment of the dam, were filled with concrete to prevent the material of the revetment from washing out. The pile revetment below the east abutment was extended 265 linear feet farther down the river, making the revetment below the east abutment 310 feet long. Eight days of casting were done by the dredge to get the necessary material back of the sheet piles to fill out the slope where the eddy had cut the bank away. After the filling was cast back of the sheet piles, 917 cubic yards of it were moved with wheel scrapers, grading the slope. Riprap was put along outside of the sheet piles and up the slope to the 12-foot stage; the following materials were used in the extension of this revetment: 65 piles, 288 "Wakefield" sheet piles, 260 linear feet each of 6 by 12-inch oak and 10 by 10-inch pine wales, 34 tie-rods, and 524 cubic yards of stone. The upper end of the levee was heavily covered with riprap to protect it from scour; 40 cubic yards of stone were used. A bluff bank, where the levee joins the filling back of the head of the lock, was filled and graded.

SNAGGING.

A small crew, with the steamer *Enterprise* and dredge, removed 22 snags from the channel at McGee Creek.

KAMPSVILLE LOCK.

In December most of the plant was moved from La Grange Lock to Kampsville Lock site and the preliminary work of laying the lock walls began. Drawings and bills of material were prepared for the traveler trestle, storehouse and boarding-houses. The following materials were received: For houses, 64,600 feet B. M. of lumber, 69,000 shingles, 69 windows, 43 doors, and 14 20-foot and 3 24-foot oak sticks for foundation posts; for traveler and railroad trestles, 97,700 feet of pine, 9,880 feet of elm, 3,750 feet of oak, 700 elm ties, 208 26-foot oak piles, 65 10-foot oak posts, 4,040 pounds of iron (bolts, nuts, and washers), 1,400 pounds of spikes, and 42,589 pounds of railroad iron (rails, fish-plates, bolts, and spikes); for stone-cars, pump, platform, and floors for piling sand and coal on, 14,000 feet of elm. Eight hundred and forty-eight tons of coal were received at Columbiana and transferred to the lock site. Four hundred and ninety cubic yards of sand, for laying the lock walls, were received. A slip 110 feet long by 35 feet wide, giving a depth of 4 feet at low water (at the time it was finished), was dredged along the south side of the railroad trestle at Columbiana; to facilitate the work of transferring to the lock site the material received by rail, a chute was built at this slip for unloading coal. The brush, which had grown on the reservation and cofferdam during the suspension of work, was cut and burned. A rough topographical map was made of the lock ground, showing the fences, houses, cofferdam, stone piles, and 4-foot contours. The high waters had deposited mud on the foundation to within less than a foot below low water; to remove this deposit, a cut was dredged through the cofferdam and dredges were put at work dredging the mud into dump scows; the dredging was commenced within the lock pit February 17 and suspended June 30; from April 1 to May 18 dredging was suspended because of the high water; in making the cut through the cofferdam, 1,000 cubic yards of material were removed. There were 25,114 cubic yards of mud removed off from the foundation by our dipper dredges, most of this material being dumped east of the channel, above the site of the dam. From June 11 to June 27 a 12-inch centrifugal sand pump, chartered of the Eagle Sand Company, of St. Louis, was at work day and night trying to pump mud off from the foundation. Where the sediment was soft the pump could take it up readily, but where the sediment was hard the pump could do very little toward removing it. Sluices were built so that the material the pump raised was carried over the cofferdam out of the lock pit. It is difficult to estimate how much mud the Eagle Sand Company's pump removed off from the foundation, but from soundings taken it is apparent that very little was accomplished. A 1,200 candle power "Wells light" was used for our night work. One hundred and thirty-two piles of the old cofferdam were pulled. The two old 6-inch centrifugal pumps that were used heretofore to pump out this and the La Grange cofferdams were furnished with new frames and placed 2 feet below the level of the foundation; the pumps can be lowered 4 feet below the level of the foundation. Two New Era boilers and engines to drive the pumps were also placed ready for work. Trial runs were made with our pumps and they seem to be in good working order. Before the pump frames could be set a wreck-heap of timbers and drift had to be removed by our dredge. Thirteen piles were driven, eight to support the pump frames and sluices, two to support the coal chute at Columbiana, and three for snubbing posts outside of the cofferdam.

PLANT.

Dredge No. 1.—Four new timber heads were made; the upper bearing of the swinging shaft was strengthened by two braces made of railroad rails; a new hoisting chain and spider, a new backing chain, new pillow-block cap, new knuckle on hoisting drum, new 4-inch swinging shaft, and four new rubber bumpers for the swinging-shaft carriage were purchased; 60 square yards of new canvas were put on the roof and painted two coats; the last paint of coat was sanded; the friction blocks on the hoisting drum were set out far enough to give five-eighths of an inch of wood to be worn away; a few valve stem was made for the main engines; the capstan was overhauled and repaired; nine teeth in the crown wheel were repaired.

Dredge No. 2.—The crosshead frame of the crane was reinforced by 2½ by 6-inch iron straps; two new spuds were fitted with heavy racks; a set of new dipper handles were made; the crane yolk, dipper latch, latch lever and guard, pillow-block key, hoisting-drum lever, friction belt, backing chain, spud-block stirrups and linings to both fire-boxes were repaired; a 20 by 30 inch patch was put on one boiler and four tubes were put in; the hoisting drum friction-blocks were set out far enough to give five-eighths of an inch of wood to be worn away; four new rubber bumpers were put on swinging-shaft carriage; a new stirrup was made for the stern spud; the A braces at the bow of the truss were reinforced by new angle irons; seven new stud bolts were put in the steam chest of one of the main engines; a bulkhead between the engine and boilers was built and painted; 65 square yards of new can-

was were put on the roof and painted two coats; the last coat was sanded. While dredging part of the mud off from the Kampsville Lock foundation the 2½-yard dipper was used instead of 1½-yard dipper.

Steamboats.—The *Hebe's* new boiler has leaked a good deal at the ends of the tubes; the tubes were calked several times; the engine levers were moved from along the boiler aft of the boiler, where the engineer can see both engines as he handles them; the boiler was covered with cement felt 1½ inches thick, and the steam pipes were covered with asbestos felt; a new stock was made for the rudder; a hood was put at the sides and back of the ash pan, to prevent the dust from the ashes flying back on the engines; new buckets of elm were put on the wheels, care being taken that the wheels were balanced; the pillow blocks of the wheel shafts were blocked up and new cap and holding-down bolts were made; a new flagstaff, three new carlings with light chains, three new stanchions, and five new fenders were made; the hull and woodwork was thoroughly painted; an engineer flag was furnished.

Enterprise.—A new wheel flange, twelve new double extra heavy gas-pipe wheel-arms, and three new heavy buckets were put on the wheels; the engine beds were more securely bolted to the floor beams; the engines were thoroughly overhauled and the shafts lined; two new chimneys were purchased; the sides of the furnaces were lined with common fire brick instead of the tile formerly used; both of the boilers over the furnace were patched and fifty-nine new tubes put in; the cabin was closed around the boilers and a partition built between the boilers and engines; the outside of the cabin was painted; two new rudder stocks and one new rudder were made; 200 square feet of new docking were laid in the engine-room; four new hatches were made. The *Enterprise* sunk in 9 feet of water, March 21, but was raised and put to work, having lost 3 days' time.

Barges and scows.—The 18 by 50 foot barge was hauled out on the ways and shortened to 46 feet; the bottom, sides, and rakes were calked; the top streaks of both gunwales, the plank shear, and nosing were renewed. The 20 by 100 foot barge was hauled out on the ways and 2 head blocks, 4 corner-rake timbers, 24 pieces of rake plank, 44 linear feet of nosing, 2 linear feet of plank shear, and 31 square feet of graven pieces were made and put on; all the seams were calked. The dump scows were being continually repaired, and then could not be made to do their work.

Shop.—A new 20-inch nosing was put on the boat and 4 hatch gratings were repaired; a foundation was built at Kampsville and the shop moved from the barge to it.

The small provision house on one of the 16 by 33 foot barges was made into an ice house.

Office boat.—The skylight was covered with new canvas (85 square yards) and painted two coats; the last coat was sanded; the woodwork inside and out was thoroughly painted, two new smokestacks were put up, one new fender, two new kevels, and one end chock were made; the rooms in the after part of the boat were changed so as to give more dining-room space.

Buildings for Kampsville Lock and Dam.—The old 16 by 72 foot two-story boarding-house was moved down to Kampsville Lock from La Grange Lock. Four new buildings were erected as follows: A two-story boarding-house 18 by 100 feet, with a one-story 18 by 30-foot L; a two-story sleeping house 18 by 36 feet, a 14 by 18 foot bakery, and a 20 by 38 foot storehouse. The storehouse was placed on posts above high water; the two-story house used by the watchman and his family during the past 6 years was fitted up for foremen's quarters. These six buildings and the small house the gardener lives in were whitewashed.

Pile drivers.—Eighty new tubes were put in the boiler of one pile driver; half of the friction blocks of another were renewed and one set of new cylinder rings were put in; the engines of both drop-hammer drivers were thoroughly overhauled and are in good condition.

Derricks.—The mast of one derrick at La Grange was filled with new wood; the woodwork of the three at Kampsville was all renewed; the masts are 20 feet high and the booms 40 feet long.

Pumping machinery.—The New Era boilers and engines, that will be used to drive the pumps, were extensively repaired; the fire boxes were relined and fifty-five new tubes were put in; two new smokestacks were purchased; the old 6-inch centrifugal pumps were also put in pretty good condition, the shafts were straightened and lined and boxes babbitted.

Stone cars.—The frames of eight stone cars were renewed.

Travelers.—The engines of the two overhead travelers were overhauled and put in running order; one bridge was rebuilt, the span being changed from 24 feet to 30 feet; the bridge of the other traveler will be rebuilt and the span increased to 30 feet.

Skiffs.—The skiffs were kept repaired and painted.

Tools.—The tools in general use were kept repaired.

The plant on this work is very much deteriorated, so that constant and expensive

repairs fail to keep it in a good working condition. The dredges and dump scows can not be made to do half the work they should.

Two wells for the use of the employes were dug on the United States reservation at Kampsville Lock.

The following work is estimated as necessary to entirely finish the work at La Grange Lock: Place 2,500 cubic yards of stone below the dam; finish filling the pile revetment below the lock, and build the revetment above the lock; build permanent quarters for the lock-keepers; place 9,300 cubic yards of earth filling around the superintendent's house.

Very respectfully, your obedient servant,

W. M. CHILDS,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The following figures are taken from the annual report of the Merchants' Exchange, St. Louis, Mo., for the calendar year 1890.

Arrivals and departures of steamboats and barges at St. Louis, Mo., via the Illinois River.

Month.	Arriv- als.	Depart- ures.	Month.	Arriv- als.	Depart- ures.
January.....			August.....	12	12
February.....	6	4	September.....	4	5
March.....	7	11	October.....	7	7
April.....	15	13	November.....	6	5
May.....	13	12	December.....	3	1
June.....	13	15			
July.....	15	10	Total.....	101	96

Receipts and shipments in tons via the Illinois River, at St. Louis, Mo., 1890.

Month.	Receipts.	Ship- ments.	Month.	Receipts.	Ship- ments.
January.....			August.....	2,205	430
February.....	1,730		September.....	1,030	250
March.....	1,900		October.....	2,090	475
April.....	3,215	420	November.....	1,150	660
May.....	4,295	150	December.....	230	40
June.....	2,490	730			
July.....	2,435	465	Total.....	22,770	3,620

The estimated local tonnage on the Illinois River during the year 1890, not reporting at St. Louis at all, is from 75,000 to 115,000 tons, making the entire tonnage of the river, including receipts and shipments at St. Louis, from 100,000 to 140,000 tons a year, varying with the stage of water in the river.

The following figures of business passing through the Henry and Copperas Creek locks were furnished by the collectors stationed at the locks.

Henry Lock.—The aggregate tonnage of boats passing through this lock during the calendar year 1890 was 44,849 tons.

The commodities carried through the lock are as follows:

	Tons.
Grain.....	8,750
Coal, hay, and iron.....	650
General merchandise.....	378
Total.....	9,778

Passengers carried..... 4,873

About 25 per cent. should be added to the above for freight and passengers carried over the dam at high water stages.

2630 REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY.

On the stretch of the Illinois River from Peoria to Henry daily trips are made by steamboats, which carried not less than 7,000 passengers and 450 tons of freight during the calendar year which are not included in the lock reports.

Copperas Creek.—Freight passing lock:

	Tons.
Grain.....	4,907
General merchandise.....	2,058
Coal.....	1,065
Total.....	8,030

The aggregate tonnage of boats passing the lock is 32,191 tons.

MM 5.

OPERATING AND CARE OF LA GRANGE LOCK, ON ILLINOIS RIVER, ILLINOIS.

Under the indefinite appropriation for "operating and care of canals and other works of navigation," as provided by section 4 of the river and harbor act of July 5, 1884, the La Grange Lock has been operated and kept in repair during the past fiscal year.

Nine hundred and eighty-five lockages were made, showing an increase of 44 per cent. in the number of steamboats, and 31 per cent. in the total number of lockages over a similar length of time the year previous. The valve gearing of the lock was repaired; the approaches to the lock kept dredged, the old cofferdam removed; and nearly 22,000 cubic yards of dredged material filled in back of the land wall, and as backing to the dam. The Government reservation was cleaned off, graded, sown in grass, and fenced in. The lock force, when not engaged in operating or repairing the lock, were kept at work on the revetments of banks above and below the lock, and in grading and keeping clean the United States lock grounds.

A centrifugal pump and attachments were purchased for a pump dredge to keep clean of mud the gate and valve recesses of this lock, but the pump has not been mounted.

The amount expended during the year is \$9,275.03, a detailed statement of which is herewith.

Under the same appropriation it is proposed during the fiscal year ending June 30, 1892, to operate the lock and keep it in repair, and to maintain by dredging the present depth in the approaches to the lock and in the pool above it, for which an estimate of \$10,000 is made.

Money statement.

July 1, 1890, amount available	\$10,720.00
June 30, 1891, amount expended during fiscal year	9,275.03
July 1, 1891, balance unexpended.....	1,444.97
July 1, 1891, outstanding liabilities.....	834.47
July 1, 1891, balance available.....	610.50

Expended during the fiscal year ending June 30, 1891, from the indefinite appropriation for "operating and care of canals and other works of navigation" in operating and keeping in repair the La Grange Lock, on the Illinois River.

Services of lock tenders and watchmen	\$4,035.90
Services of crews of dredge and tender	1,247.02
Fuel for dredge and tender	502.80
Ballasting and framing La Grange Dam, labor	57.45
Repairs and supplies to plant	680.19
Spud racks for dredges	73.64
Valve gearings for lock gates	32.27
Repairs to lock gates and valves, labor	518.36
Oil and supplies for lighting lock	96.49
Subsistence stores and labor	926.34
Filling back of lock house, labor	6.50
Building pile revetments, labor	666.18
Tie rods for pile revetments	12.62
Lumber for repairs to lock gates	52.00
Cistern for lock house	8.25
Supplies for employés' quarters	44.28
Diving dress, for use in examining lock valves	41.15
Tools, etc.	6.00
Posts and wire for fencing United States lock land	44.42
Miscellaneous labor caring for lock	118.20
Grass seed for sowing lock grounds	8.10
Mileage	37.92
Toilet supplies for office	2.25
Stationery	18.45
Rent of telephone	31.25
Rent of post-office drawer	4.00
Traveling expenses	3.00
Total	9,275.03

REPORT OF MR. W. M. CHILDS, ASSISTANT ENGINEER.

KAMPSVILLE, ILL., July 1, 1891.

SIR: I have the honor to submit the following report for the operating and care of La Grange Lock, Illinois River, for the year ending June 30, 1891:

The river was closed by ice during the first 20 days of January, and no boats passed the locks. During the year 985 lockages were made. A tabulated statement of the lockages and a list of the names of the steam vessels that have passed through the lock are herewith.

Comparing the lockages of last year, from October 21 to June 30, with the same period of this year an increase is shown of 31 per cent. in the total number of lockages, and an increase of 44 per cent. in the number of lockages of steam vessels.

For a short time during the winter the lock force was reduced to the superintendent and two watchmen. As the spring navigation opened the force was increased to one superintendent, one blacksmith, one carpenter, and three lock-tenders.

Repairs.—During the low-water season of 1890 five of the upper valves could not be opened with the head against them. A diver was sent down to examine these valves, and he found that the valve supports had settled until the spur segments were too low to engage with the pinions. These five pinions were taken off and replaced by others of diameter large enough to make them mesh properly with the spur segments on the valve shafts. The valves of the lower gates, sixteen in number, proved to be too hard to open with the head of an ordinary stage of the river against them, so intermediate shafts and gearing were added to increase the power of moving the valves about 2½ times. Two spur wheels of this new gearing broke and were renewed. The flooring on the tops of the upper gates was taken off and new tops of 2-inch decking were laid. The tops of the lower gates will also be renewed. Four-inch nosings were put on the lower or downstream sides of the gates, to keep passing boats from striking the gate suspension rods. Where the revetment below the land wall gave way the filling against the sheet piles was dug out, 70 days' work being done, and the row of sheet piles was pulled back into a straight line. During the high water thirteen additional anchor piles were driven 30 feet back from the face of the dike; the tie-rods for these thirteen anchor piles will be put in during the low-water season.

Quarters.—In the lock superintendent's house two rooms and the hall on the first floor were painted. The small house used last year for the lockkeeper's quarters was torn down and the material used to enlarge the storehouse. Since this house was torn down the lockkeepers have used an old quarter boat, which is on blocks on the river bank, at the lower limit of the United States reservation, for their quarters.

Dredging.—Two thousand two hundred and twenty-one cubic yards of filling material were cast back of the land wall; 4,500 cubic yards of filling material were cast back of the pile revetment below the lock; 2 days' dredging were done below the lock and 3 days' dredging above the lock, to give a sufficient depth of water to float the pile-driver to drive the piles for the revetments. Two shoals in the approach to the lock from below were removed by dredging; 2,404 cubic yards having been dredged into dump-scows and put out of the channel along the east side of the river. Of the material used in filling back of the lock and back of the revetment below the lock 4,042 cubic yards were dredged from the channel below the lock. The filling back of the lock was graded and sown in mixed lawn grasses; in doing the grading 6,128 cubic yards of earth were moved by wheel-scrapers.

LA GRANGE DAM.

Dredging.—Fifteen thousand two hundred and thirteen cubic yards of dredged material were put against the face of the dam; some of the filling material had to be handled a second time, the dredge casting it, to get it close to the dam; of this material 1,104 cubic yards were taken from the lock chamber. The total amount of dredging done by the "Operating and care," La Grange Lock, was 21,759 cubic yards dredged into scows, of which at least 7,000 cubic yards were handled a second time by being cast back of the lock or revetment below the lock, or down to the dam.

Pile revetments.—The lock force put the 42 tie-rods in the pile revetment below the lock, 3 being fox-keyed into the land wall; the filling will be completed and the slope ripped. The pile revetment above the lock is to be built by the "Operating and care" force; 194 Wakefield sheet piles, 6 by 12 inches, were made.

The lock-tenders, when not engaged in operating the lock, worked on the dam or pile revetments. Three thousand one hundred linear feet of hard-wood picket fence were made and the United States reservation on the east and west side of the river was fenced. Two hundred and forty-eight oak posts and 7,360 oak pickets were made. A strong wooden snubbing post was set back of the head of the lock for the use of passing tow boats. The engines and two boilers, off of the old steamer *Teggs*, were moved across the river to the lock side and housed. Thirty-four blacksmith tools were made. One hundred and eighteen tons of clear ice, from 5 to 7 inches thick, were harvested. The United States reservation has been pretty well cleared of old lumber and property, and the lock and grounds are becoming quite attractive. The ice house and storehouse were whitewashed.

The upper approach to the lock has filled so that there are places where there is less than a 5-foot depth of water at low water.

An 8-inch centrifugal pump was purchased in June. It will be fitted up on a barge and used to pump mud out of the lock from around the gates and valves.

The report for improving Illinois River shows the following work estimated as necessary to entirely finish the work at La Grange Lock: Place 2,500 cubic yards of stone below the dam. Finish filling the pile revetment below the lock and build the pile revetment above the lock. Build permanent quarters for the lock keepers. Place 9,300 cubic yards of earth filling around the superintendent's house.

Very respectfully, your obedient servant,

W. M. CHILDS,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

Lockages made at La Grange Lock, 1890-'91.

Class.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	Total.
Steam vessels	36	16	23	22	24	5	...	6	15	49	38	37	271
Sailing vessels	5	5	2	2	6	3	...	...	5	10	7	4	46
Flat and cabin boats	49	43	41	42	51	24	6	11	26	34	32	52	410
Skiffs	41	19	22	46	93	17	2	5	...	5	...	...	254
Illinois River improvement boats .....	...	...	...	...	...	...	...	...	...	...	...	...	...
Total	131	83	88	112	174	50	7	22	46	98	81	93	985

Names and tonnage of steam vessels that have passed this lock.

Name.	Tons.	Name.	Tons.	Name.	Tons.
Belle of Ottawa	10	Ethel	5	Lottie	5
Calhoun	637	H. W. Longfellow	47	Lotus	20
City of Florence	358	Ida	5	Niagara	96
City of Pekin	10	Imperial	66	Polar Wave	150
D. H. Pike	465	Jack Frost	350	R. A. Speed	140
Despatch	5	John Rohn	40	Reindeer	50
Dick Clyde	70	Joliet	78		
Emma	17	Lily (U. S.)	300		

M M 6.

CONSTRUCTION OF ILLINOIS AND MISSISSIPPI CANAL.

The object of this improvement is to furnish a navigable water way from Lake Michigan to the Mississippi River, at the mouth of Rock River, in connection with the Upper Illinois River, and the proposed enlarged water way along the present line of the Illinois and Michigan Canal.

The item of the river and harbor act of September 19, 1890, under which work upon the construction of this canal begins, is as follows:

For the construction of the Illinois and Mississippi Canal to connect the Illinois River at a point near the town of Hennepin with the Mississippi River at the mouth of Rock River, together with a branch canal or feeder from said Rock River to the main line of said canal, \$500,000. Said canal and feeder shall be known as the Illinois and Mississippi Canal, and shall be constructed on the route located by the Secretary of War in pursuance of the provisions of "An act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors and for other purposes," which act became a law August 11, 1888, and said canal and feeder shall be 80 feet wide at the water line and 7 feet deep, the locks 170 feet in length, and 30 feet in width, and shall have a capacity for vessels of at least 280 tons burden, with guard gates, waste weirs, locks, lock houses, basins, bridges, and all other erections and fixtures that may be necessary for safe and convenient navigation of said canal and feeders, and shall be constructed on plans and specifications to be approved by the Secretary of War: *Provided*, That the Secretary of War shall in his discretion change or alter the dimensions of the locks of said canal and feeder if in his opinion the cost of said improvement is not thereby increased.

It shall be the duty of the Secretary of War, in order to secure the right of way for such canal and feeder, to acquire title to such lands as may be necessary by agreement, purchase, or voluntary conveyance from the owners, if it can be done on reasonable terms; but if that should be found impracticable, then the Secretary of War shall apply at any term of the circuit or district court of the United States for the northern district of Illinois to be held thereafter, at any general or special term held in said district, and in the name of the United States institute and carry on proceedings to condemn such lands as may be necessary for right of way as aforesaid; and in such proceedings said court shall be governed by the laws of the State of Illinois, so far as the same may be applicable to the subject of condemning private property for public use: the Secretary of War to cause said work to commence as soon as practicable by the construction of one of the locks and dams on said Rock River at such point as he may deem most advisable, and shall cause said work to be constructed in accordance with the foregoing provisions and of permanent and substantial materials and in a good and workmanlike manner.

With reference to this work it is to be said that various surveys of different routes from the great bend of the Illinois River to the Mississippi River at or above the mouth of Rock River have been made. In 1871 G. P. Low (see Report of Chief of Engineers, 1871, page 303 *et seq.*), also in 1882 Major Benyaure (Report Chief of Engineers, 1883, page 1757 *et seq.*), and in 1885 Major Handbury (Report Chief of Engineers, 1886, page 1709 *et seq.*).

There was also a report upon this canal by a Board of Engineers, in 1887, under the provisions of the river and harbor act of August, 1886 (Report Chief of Engineers, 1887, page 140 *et seq.*). All of the local engineers since 1882, and the Board of Engineers of 1886, for engineering reasons have preferred and recommended the Marais D'Osier route, but for commercial reasons the Chiefs of Engineers, Generals Newton and Duane, and the Secretaries of War preferred the Rock Island route, and that route has been finally adopted.

With reference to these surveys it is to be said that they have all been made for preliminary and comparative purposes, and have been confined to an horizon too narrow to admit choice of location along the various routes.

In all, for surveys, there has been expended less than one-half of 1 per cent. of the cost of the adopted line, and but little more than one-sixth of 1 per cent. of the cost of all the various routes estimated upon.

These surveys were sufficient for the purposes intended, and the preliminary locations and estimates based thereon were well studied and placed, but for a *final* location of the canal and for perfected results they are insufficient in horizon. The lines surveyed may be generally the best lines, but in many places, doubtless, the preliminary locations may be bettered and the cost of the completed work to the public reduced.

In short, although the previous surveys, with very limited means, were sufficient for preliminary estimates of relative cost of various lines, they may be insufficient for final and definite locations upon which contracts may be based. Yet under the act of Congress of August 11, 1888, detailed plans and estimates based upon these preliminary surveys were required and submitted June 21, 1890, the report of which location, plans, and estimates (without maps and drawings) was published by Congress as House Ex. Doc. No. 316, Fifty-first Congress, first session.

This report was evidently the basis of the item in the river and harbor bill approved September 19, 1890.

In preparing a project for the expenditure of the appropriation contained in that act, it was considered as restricting the work to locks and dams in Rock River, and to securing the necessary lands for sites of constructions, and for right of way for the canal.

Of the locks and dams in Rock River the most important are: 1st, at the head of the feeder; and, 2d, near the mouth of Rock River.

For the feeder all previous surveys have been based upon the premise that the summit level is 204 feet above the level of the Illinois River at or near Hennepin, and the lines of survey have been directed to the first point on Rock River that could feed a level at that height, *i. e.*, to Dixon, Ill., above the dam at that point. It is probable, however, that by cutting down the summit level not exceeding 9 feet that the feeder may be shortened one-third in length and an aqueduct and three locks be avoided, which consummation is worthy of further investigation before any of the feeder works be undertaken. Moreover, the lock and dam at the head of the feeder can be of no practical use until the canal is completed over either the eastern or western section as far as to the summit level, and the feeder constructed throughout.

On the other hand, upon the completion of the works at the mouth of Rock River and its immediate vicinity, Rock River will be made navigable at mean stages as far as to the terminus of the canal proper at the head of Penney Slough, or for 27 miles, and be available for the transportation by water of material required in the construction of the canal.

For these reasons it was recommended by me in the project submitted October 2, 1890, that work begin at the mouth of Rock River, and that the appropriation be expended in completing the works at that point, estimated to cost in the report of June 21, 1890, \$491,257, but that more detailed surveys be made in this vicinity to secure, if possible, a better location of the canal and works of navigation.

Before the approval of this project a question arose under the part of the act providing that the Secretary of War "in his discretion (shall) change or alter the dimensions of the locks of said canal and feeder, if in his opinion the cost of said improvement is not increased thereby." The correspondence with the Chief of Engineers on this subject is appended hereto.

The project was approved by the Chief of Engineers November 1, 1890, the locks to be 30 feet in width and 170 feet in length, as specified in the act.

Upon the approval of the project a survey party under Assistant L. L. Wheeler, a gentleman of many years' experience under the War Department, was organized, and a thorough survey of the vicinity of the mouth of Rock River made. The report upon this survey and my recommendations in the matter are herewith appended.

The results of this survey were:

(1) That the estimates of the cost of the right of way via the Sears Canal and northern line were far from the truth; that parties owning the lands and sites needed would demand and exact, as far as the courts would allow, values for their property based upon the value of the water power to be created by the United States works.

(2) That a more certain improvement could be made on the south side of Rock River terminating at the legal terminus than via the northern route, and without in any manner further developing, injuring, or destroying existing water powers, and at materially lower cost.

As one of the further results of this survey it was ascertained that along the southern route in excavating the canal, beds of clean sand and gravel containing less than 3 per cent. of impurities are encountered, and rock to be excavated nearly sufficient to construct all of the dams, locks, weirs, riprap of banks, etc., and other mechanical works, which fact constitutes a very economical and favorable condition.

This survey also showed that the proposed plan of erecting dams to the elevation 131 above canal datum across the south channel of Rock River at Milan was entirely impracticable due to the low position of the town of Milan and lands above it, and that the submitted designs could not be carried out without greatly increased expense. Modifications therefore were made for the northern route, placing the dam across the south branch of Rock River at the head of Carr Island, instead of for the northern line at Milan, and across both branches for the southern line, and comparative estimates submitted by Mr. Wheeler upon this basis.

The resulting estimates were:

For the northern line	\$498,574
For the southern line	411,529
In favor of southern line	87,045

In view of the eight-hour-a-day law, and the contingencies of works subject to flood, all these estimates are probably too low by at least 20 per cent., but it is believed they are correct relatively, and may serve as approximate estimates of the relative cost of the two routes.

In connection with the surveys forms for voluntary agreements to sell and purchase the lands required for right of way, etc., over the two

routes, were submitted to the various land-owners along the two routes, and propositions received from some of them as shown below.

Northern route.

Name of owner.	Estimate.	Proposition.
John M. Gallagher.....	\$388.75	\$1,937.50
M. T. Johnson.....	40.00	270.00
T. J. Robinson.....	2,970.00	50,000.00
Rock River Land and Lock Co.....	22,500.00	22,500.00
Phillip Dingleline.....	240.00	400.00
William L. Coyne.....	710.25	1,000.00
Total.....	26,850.00	76,107.50

Southern route.

Charles Oscar Hanson <i>et al</i>	\$811.20	\$812.00
John Findall.....	1,580.00	1,196.00
Merritt Goble and wife.....	233.40	234.00
David Payne and wife.....	159.00	159.00
Anders Peterson.....	337.00	437.00
Vandruft heirs.....	468.50	468.50
Luken & Bachman.....	82.00	177.00
William L. Coyne.....	318.00	1,000.00
M. T. Johnson (including right of way not estimated).....	672.75	1,189.00
Sears Brothers.....	2,500.00	5,000.00
Peter Fries.....	1,430.00	1,430.00
Swan Johnson estate.....	1,183.75	1,000.00
Total.....	9,585.80	13,102.50

Along the southern route thirteen propositions were received, differing \$3,516.90 (more) from the estimate. Along the northern route six propositions, differing \$49,257.50 more than the estimate. It was evident that, irrespective of the cost of the two routes as a purely engineering question, the owners of lands required along the northern route were bent either upon getting great prices for lands free from encumbrances, or upon securing to themselves all water-powers developed by the United States works, and to place the United States in the position of guarantying to those riparian owners the enjoyment of the use of water-powers developed by the United States at public expense and of ultimately, if not at this time, demanding of the United States the maintenance of these powers at public expense for private gain.

Fortunately, however, without any reference whatever to costs of right of way and water-powers, as a purely engineering question, the southern line is the only route so far developed and known by which the legal terminus of the route can *certainly* be attained at reasonable expense, by a canal carrying 7 feet of water throughout. The northern line is obstructed from the foot of Turkey Island to the mouth of Rock River by shifting sands, from 2 to 3 feet depth of water at low water, which experience on the Upper and Lower Mississippi shows can not *certainly* be increased to, and maintained at 7 feet depth at low water, by the application of the method of contraction by brush dams or by dredging in a channel through moving sands.

For the above reasons the passage of the lower Rapids of Rock River by means of a canal upon the south side of Rock River, excavated in the banks and secure from injury by water, except for a short section some 4,000 feet in length, constructed on the bed of Rock River by paved embankments, was recommended for approval March 19, 1890,

and under the law was approved by the Secretary of War March 25, 1891.

This location was at once contested by private interests situated along the northern line on the grounds.

(1) That the approved plans injured or destroyed existing water-powers.

(2) That the route had been already fixed along the north shore under the acts of August 11, 1888, and September 19, 1890, and that it could not be changed except by act of Congress.

With reference to the first point it may be said that the proposed dams are across the chutes at the *head* of the rapids. Existing water-powers are at the foot of the rapids, and the dams lower than proposed by the United States. It is clear that the entire flow of Rock River, except the small quantity required for lockages, etc., will continue to pass over the crests of the dams and past the sites of these water-powers where it can be as well utilized after the construction of the dams as before. It is proposed to construct sluices in the dams to maintain any reasonable division of the water flowing down the chutes, but it is evident that the interests along the north shore will obstruct the execution of the work. The dams, however, may be moved, and instead of two dams across the arms of Rock River a single dam may be built above the head of Carr's Island, which will allow the flow of Rock River to take its own course down the various channels, and remove from these parties any ground or pretense that the United States works interfere with the relative discharge of these channels. It is not proposed to interfere with the water-powers in any way except by taking the water necessary for navigation, or by extinguishing water-power rights where necessary to interfere with them.

With reference to the claim that the route of the canal has been absolutely and rigidly located, it may be said that the *route* has been approved in general terms, and location, plans, and estimates in detail prepared and submitted. In submitting these detailed plans and estimates (see Report Chief of Engineers, 1890, p. 2588), it was stated—

The plans and estimates herewith submitted must be understood to represent the best results suggested by preliminary surveys along a definite surveyed line, covering too narrow an horizon to admit any material choice of location. When the work is definitely undertaken the vicinity of this line must be further examined to better if possible the location shown upon the maps.

These locations, plans, and estimates have never been formally approved by the Secretary of War, and certainly it would be a strange condition indeed if the United States officers can not at any time during construction of a work of this magnitude recommend and make, within ordinary reasonable limits, any changes in either locations or constructions advantageous to the United States, and tending towards the security and efficiency of the work, and especially in securing rights of way there must be some elasticity to the line of the canal or the United States would be at the mercy of speculators in their necessities.

In the progress of the survey near the mouth of Rock River it was ascertained by the borings that deposits of clean sand and gravel of considerable extent, and much stone would be taken from the prism of the canal, if the southern line were adopted, and in view of the fact that the building stone available is of a class that is not very durable, and of the further fact that engineering constructions of similar character to those required upon this canal have been constructed abroad to a great extent of artificial stone of Portland cement, and the adop-

tion of that material would very materially reduce the cost of the masonry of the canal and allow without increased cost an increase in the width of the locks and a change in the bridges from fixed to pivot which latter change will convert the canal from a barge to a steamboat canal with great increase in its utility, application was made to the Chief of Engineers for permission to construct the masonry of the three locks, and the abutments of the dams at the lower rapids of Rock River, of artificial stone of Portland cement and materials excavated from the prism of the canal, and that the locks be increased in width 5 feet to accommodate a large part of the fleet of steamboats navigating the Upper Mississippi River.

This application was approved under that provision of the act of September 19, 1890, which authorizes the Secretary of War to change the dimensions of the locks if it seems advisable and can be done without increasing the cost of the canal.

Plans of the locks required have accordingly been prepared upon this basis.

Full descriptions of all lands and sites required for the construction of the lower 4 to 5 miles of the canal in accordance with the approved line near the mouth of Rock River, together with all voluntary agreements received for the sale and purchase of right of way, are now in the hands of the district attorney for the northern district of Illinois for examination of title and preparation of condemnation suits, etc., as required by the law.

Until titles to these necessary lands and sites are obtained, the actual work of construction on the canal can not begin.

PROPOSED APPLICATION OF FUNDS NOW ON HAND.

It is proposed to apply these funds to the purchase of rights of way for, and to the construction of the 4 to 5 miles of the canal just above the mouth of Rock River with its dams and works of navigation.

PROPOSED APPLICATION OF THE FUNDS ASKED FOR, FOR THE FISCAL YEAR ENDING JUNE. 30, 1893.

It is proposed to apply these funds to the determination of the final location of the canal, to the purchase of rights of way along this location, and to prosecute towards completion the work on the canal and feeder.

In this connection it is repeated that it is desirable to make additional examinations to ascertain the most advantageous level for the summit level and the shortest and most advantageous feeder line for the supply of this level, with a view if possible to diminish the lockage, number of locks and aqueducts, and length of feeder line, also along the main line examinations should be made to determine whether the summit level may be advantageously reached otherwise than by the valley of Pond Creek where the available space is very restricted and the canal construction difficult on account of the occupation of that valley by the double track of the Chicago, Rock Island and Pacific Railroad.

GENERAL REMARKS.

This canal is designed as a cut-off or short route from the Upper Mississippi to Lake Michigan in connection with the present existing water

lines, or with improved routes of greater capacity that have been contemplated for years.

The existing route is (1) via Illinois and Mississippi Canal 97 miles to La Salle; (2) Illinois River from La Salle to its mouth at the Mississippi River, 223 miles; (3) mouth of the Illinois to Rock River, 287 miles.

The present water route from the Chicago at Bridgeport to the mouth of Rock River is, as shown, 607 miles, while by way of the proposed Illinois and Mississippi Canal it will be 183 miles only, a saving in distance from Lake Michigan by water to all points on the Mississippi River above the mouth of Rock River of 419 miles over existing water routes. The route via the proposed canal will be shorter than via the Illinois River to all points on the Mississippi River above a point 78 miles by water above the mouth of the Illinois, and 209 miles below the mouth of Rock River. Above the mouth of Rock River to St. Paul are 401 miles of river navigation, so that the proposed canal as a cut-off will shorten the distance from Lake Michigan by water to all points along the Upper Mississippi River for 610 miles of its length.

The Illinois River for 14 miles below La Salle forms one link in the proposed water route, but the rest of the distance, 97 miles from La Salle to Chicago, the route is continued by the Illinois and Michigan Canal, a work of much less capacity than the proposed canal. Boats of the full capacity of the locks of the Illinois and Mississippi Canal must stop at La Salle and transfer cargo to the less capacious Illinois and Michigan Canal.

To secure, therefore, the full benefits of the proposed canal the water route from Chicago to La Salle must be enlarged or the capacious channel now being constructed on the lower Illinois River to be extended to Chicago via the Illinois and Desplaines Valley and a cut across the Chicago divide. Without such works the Illinois and Mississippi Canal will be of comparatively small significance. The canal constructed even on the present basis will necessarily modify, reduce, and regulate freights moving between Upper Mississippi River points and Lake Michigan, and its construction be justified upon the present basis. Its utility will, however, be gauged by the capacity of the inferior Illinois and Michigan Canal until the capacity of the latter is made at least equal to that of the proposed canal.

The commercial advantages of this route have been many times presented to Congress, notably by Maj. W. H. H. Benyaurd, Corps of Engineers, in the Annual Report of the Chief of Engineers in 1883, by Major Handbury in 1886, and by the Board of Engineers specially constituted to consider its relations to commerce, in 1886, in its report published in the Annual Report of the Chief of Engineers for 1887.

At present rates of appropriation, \$500,000 once in 2 years, it will take 28 years to complete this canal, before the termination of which much additional money will be required to maintain the work previously done, and as the work will be of no special utility until completed throughout its entire extent, it is manifest that provision should be made for its much more rapid prosecution. Even at the rate of appropriation herein, \$1,700,000 biennially, it will take 8 years to complete this work, which is a reasonable and practicable time.

ESTIMATE.

For surveys for accurate locations, legal descriptions of lands required, and for rights of way	\$200,000
For construction	1,500,000

Money statement.

July 1, 1890, balance unexpended	\$152. 80
Balance available, act August 2, 1882.....	633. 66
Amount appropriated by act approved September 19, 1890.....	500, 000. 00
	<hr/>
June 30, 1891, amount expended during fiscal year.....	500, 786. 46
	11, 755. 36
July 1, 1891, balance unexpended	489, 031. 10
July 1, 1891, outstanding liabilities	100. 00
	<hr/>
July 1, 1891, balance available	488, 931. 10
	<hr/>
{ Amount (estimated) required for completion of existing project.....	6, 425, 960. 00
{ Amount that can be profitably expended in fiscal year ending June 30, 1893	1, 700, 000. 00
{ Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., October 25, 1890.

CAPTAIN: The proviso in the Illinois and Mississippi Canal legislation, "That the Secretary of War shall, in his discretion, change or alter the dimensions of the locks of said canal and feeder, if in his opinion the cost of said improvement is not thereby increased," was put in the bill by Senator Gorman, of Maryland, who, for many years, had been the manager and one of the directors of the Chesapeake and Ohio Canal. If I understood him correctly, his contention was that the sizes of the locks as given in the law were not in accord with the dimensions of the prism or the best dimensions of boats for navigating the prism, with a view to the most economical and profitable commerce; that there was a necessary relation between all these elements, and a size or dimension of lock that would give the greatest amount of useful return.

Have you examined this question in this light, and will you kindly report on this matter from the standpoint of Senator Gorman?

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Capt. W. L. MARSHALL,
Corps of Engineers.

REPORT OF CAPTAIN W. L. MARSHALL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., October 27, 1890.

GENERAL: With reference to the change in the dimensions of the locks of the Hennepin Canal in accordance with the views of Senator Gorman, I have to say that I have at times considered the question of the relation between canal prisms, lock dimensions, and other elements relating to the question of economy, etc., but have each time found it so complicated that no definite answer could be made that can be regarded as at all exact.

If the canal could be regarded by itself, then the most economical size of boat and lock for the given prism and *length* of canal could be determined, but it is to be regarded as an obstructive link between several diverse navigations, viz: The Upper Mississippi and its tributaries, and the channels connecting these streams with Lake Michigan, to be navigated by barges whose economical dimensions have already been determined by the conditions of navigation that exist on the Western rivers, and which will not be altered to suit the requirements of the canal prism. These barges are of 6 feet draft, and 130 feet long, and from 24 to 28 feet in width. There are other barges about 30 feet in width by 150 feet in length, or somewhat longer, that carry, full loaded, greater depth, but that with large loads can navigate this canal and will navigate it if the locks be somewhat widened.

There are also a large number of stern-wheel steamboats, mostly tow-boats, but many of which also carry freight, with from 22 to 28 feet width of beam and from 122 to 150 feet length over all, that with about the same or less cross-sectional area as the barges mentioned, require a width of lock, on account of their projecting guards, from 6 to 10 feet wider than their hulls, that can use the canal also if the locks be widened to 35 feet span.

It is evident that the canal can not meet the requirements of the case with smaller locks than already designed, if for navigation for barges such as have already established themselves on the Mississippi River and tributaries, as the fittest for the purposes to which they are put, nor unless somewhat widened for the large fleet of steamboats navigating the Upper Mississippi River. The locks are final permanent constructions that can not be altered after being built, except in length, without great expense, but the prism of the canal being almost entirely in earth, can, with the exception of a few miles in Bureau Creek Valley, be comparatively cheaply and economically, and without interfering with navigation in any way, gradually increased to any desired extent. It is evident then that the size of the prism should not be allowed to control the size of the locks, even though this prism be theoretically less than free navigation by boats that can pass the locks would require.

Theoretically for free navigation of the canal prism by boats 28 feet beam, 6 feet draft, the sectional area of the prism should be about (approximately) 1,000 square feet, instead of 486.5, consequently the canal prism is obstructive, compared with an indefinite expanse of equal depth, in some ratio to these two numbers; or with slightly greater depth should be about 140 feet mean width of section instead of 70; or, stated otherwise, for a canal 70 feet mean width and 7 feet deep (Illinois and Mississippi) the locks should be somewhat less than one-half the span proposed, and shortened to agree with the most economical length of boat of that width of beam, or say approximately, be 16 feet wide and 110 feet in length of lock chamber for navigation by vessels of 14 to 15 feet beam and 98 to 100 feet in length, 6 feet depth, about 90 tons registered tonnage or 200 tons carrying capacity. Such vessels would navigate this prism at moderate speed with not materially greater difficulty than if the canal were of unlimited expanse and equal depth.

It is very clear, however, that, although such a canal with horsepower towage would probably economically transport all of the freight that will probably pass over this route for years, it would necessitate either breaking bulk at the termini of the canal or the formation of tows in barges that will not meet economical considerations in the continuation of their journeys in the more capacious channels connecting with the canal. But it is not only a question of economy and ease of navi-

gation and the best relation between the prism of the canal and the locks, but also of the length of voyage itself regarding the canal not by itself but as only a link in more extended navigation that must be considered. Every one knows that while small boats are most economical for certain purposes and distances, which distances vary with the greater or less difficulty of navigation, yet there is a point beyond which the cost of hauling such boats with their small cargoes, considering also the interest on their values, is no longer economical. For this reason, everywhere, to meet competition over long routes and reduce cost of through transportation, vessels are increasing in size and carrying capacity, even to such a point that all artificial channels and harbors no longer show any relation between their prisms and the sectional areas of the boats that navigate them. Obstructive artificial links in the chain are less costly to navigate by such vessels than to seek by reducing the size of the vessels to meet theoretical requirements of such ratios between vessels (or locks) and channels over parts of the voyage.

So I regard the Illinois and Mississippi Canal, everywhere of sufficient width to allow any two vessels admitted by the locks (or even by the proposed somewhat wider locks) to pass each other, although more or less deficient in width and depth, of much greater value to commerce, as proposed, than it possibly could be were the locks reduced in size until only boats of such size could pass them as could navigate the prism of the canal with as great freedom and ease as they could Lake Michigan.

The canal is for navigation by Mississippi River barges, and the locks can not advantageously be reduced.

If greater ease, facility, or economy of navigation of the prism of the canal be required than given by the proposed dimensions, I should say let the economical and best dimensions of the canal prism be adopted, after practical test, to the requirements of barge navigation on the Upper Mississippi River and tributaries, which have fixed the dimensions of the locks, rather than the locks be reduced in size as required by theorizing upon the dimensions of the prism of the canal as specified in the law; or, in other words, let the requirements of existing navigation be met (if only approximately), instead of requiring the creation of a distinct system of navigation suitable only for a link of 50 miles in the 600 miles of navigation that the proposed canal is to subserve from St. Paul to Chicago. Let the greater govern.

By constructing the locks of the size proposed the more economical canal barges of smaller dimensions, towed by animals, can still navigate the canal with greater freedom with two barges at a lockage, while its usefulness will be many times extended by providing for the passage, also, of greater barges (even with obstructive navigation from insufficient prism), towed by steam, and of a large class of steamboats now in existence.

No one has heard of locks of too great capacity having ever been constructed where there is available water, but complaints of insufficient capacity of locks, even in cases where they have been constructed in accordance with theoretical requirements, are common.

The Erie Canal is a case in point, the capacity of which was doubled by doubling the locks in number by parallel locks, and now it is in question to again increase its capacity, for the same class of boats however, by doubling the length of one or both series of locks to admit the passage of two boats at one lockage.

In the case of the Illinois and Mississippi Canal the same result is attained by doubling the width of the locks beyond the theoretically

(for this prism) best span for economical canal barges, while this course also vastly increases its value, even with an obstructive prism, by extending the sphere of its utility to river barges and steamboats instead of confining it to canal barges.

I have endeavored to give herein, generally, the conclusions I have arrived at with reference to the subject-matter of your letter of the 25th instant. If greater detail is required in more exact terms it will take some time, and, as I have said, the conditions are so complex and indeterminate that only approximate results can even then be attained, for the most economical vessel, even upon the high seas or Great Lakes, is still an open question, a desideratum that every shipbuilder and vessel-owner is continually seeking. The question of what is the most economical vessel, and consequent lock and canal prism, for combined river and canal navigation is still more difficult of solution, and varies with every combination of relative lengths of navigation by river and canal, load and power employed. At best it is only guessing by hypothetical or empirical rule.

Very respectfully, your obedient servant,

W. L. MARSHALL,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. L. L. WHEELER, ASSISTANT ENGINEER.

MILAN, ILL., March 7, 1891.

CAPTAIN: I have the honor to submit the following "report upon surveys and estimates for proposed routes of the Illinois and Mississippi Canal around the rapids in the Rock River, at Milan, Ill., with map and profiles of the various proposed lines."

The river and harbor bill of September 19, 1890, appropriates \$500,000 for this work, but work did not commence until November 17 following. I came to Milan October 22, and while waiting orders, thoroughly examined the vicinity of the proposed works and prepared for making surveys covering the entire locality. The weather proved exceptionally fine during the winter, and good progress was made with the surveys. A tertiary system of triangulation was measured from the head of Carr Island to the Mississippi River, duplicate lines of levels run on each bank, numerous bench marks set, and the islands and shores covered with stadia elevations. A hydrographic survey of the Mississippi River in vicinity of mouth of Rock River was also made.

On reducing and platting the notes of these preliminary surveys, several important facts bearing upon the location and construction of the proposed work became evident. A brief general description of the locality will aid in understanding the significance of these facts.

The valley of Rock River at this point is about $1\frac{1}{4}$ miles wide and evidently is the old bed of a stream of much larger volume than that now flowing in it. The hills on either side rise quite abruptly, the present river bed being along the hills on the north side until the alluvial valley of the Mississippi is reached. The river is divided by islands into several channels, one branch leaving the main stream at Milan and entering the Mississippi by a separate mouth. The rapids commence at the head of Carr Island and extend downstream about $1\frac{1}{4}$ miles, the total fall at extreme low water being about 12 feet. High water of the Mississippi is about 5 feet higher than low water at the head of the rapids. The discharge of the stream is not known to me, but probably varies from 2,000 to 50,000 cubic feet per second. The bed rock of the valley is limestone, very much seamed and broken, without bed, and entirely worthless, except for riprap and concrete. There is no stone suitable for masonry in the vicinity. In the valley the rock is overlaid by from 1 to 10 feet of clay and sand and in some places with beds of very clean sand and gravel. In the hills the limestone is overlaid by the strata of the Carboniferous age. Coal mining is one of the industries of the vicinity, and excellent fire clay abounds.

* * * * *

The first important fact shown by this survey is that the south shore in the vicinity of Milan is too low to permit the dams being placed as proposed without serious damage to Milan and the surrounding lowlands. This necessitated placing the dam across the south channel at the head of Carr Island and the construction of embankments on the north sides of Carr and Vandruff Islands and the closing of the channel between them.

Another important fact shown is that the dam across the north channel would have to be very much higher than had been previously supposed, thereby largely increasing its cost and also making its maintenance of greater uncertainty.

The most important fact shown is that an independent and feasible route for the canal exists on the south shore and the estimates show it to be much less expensive than the proposed route along the north shore. This is the more important as it had become evident that if only one route existed the acquiring of the necessary lands for right of way and sites for structures was going to be a serious matter.

As the work of reduction and estimates progressed it became more and more evident that the southern route possessed other and more important advantages than that of being a check upon the demands of property owners on the northern route. The southern route as proposed leaves the river at the head of Carr Island by a guard lock, and down to Mill Creek the canal section is entirely on the main shore. This shore is a very stable one, the original meander stone of the United States Land Survey being still in place on the range line, and the distance on the section line to the shore above Mill Creek being the same as given by the land survey. From Mill Creek to upper end of Big Island it is proposed to carry the canal in the river bed by two parallel embankments, the branch of the river flowing south of Big Island being entirely cut off from the main stream and left as a channel for Mill Creek. From the head of Big Island to the mouth of Rock River the canal is entirely on land and presents no engineering difficulties. On the contrary, it presents great advantages in having good material for concrete and mortar in the immediate vicinity of the proposed locks and in taking the required depth to the Mississippi River, in marked contrast to the northern route, which leaves about 1 mile over which the required depth would have to be obtained by wing dams and dredging in Rock River. It also presents the advantage of passing through farming lands which can be obtained at reasonable figures, and which have not been subjected to wild-cat speculations and the consequent clouding of titles. It also offers the advantage of constructing the canal without placing the United States in a position of either purchasing decayed water-powers, or entering into relation with owners of water-powers which would probably prove expensive and unsatisfactory in the end.

The northern route has been previously estimated on by yourself. The same route is followed in these estimates except the change made necessary in the location of the dams.

In the estimates submitted herewith, the cost of structures as far as they were similar have been taken directly from the estimates given in your report to the Chief of Engineers, dated June 21, 1890, and the prices given therein have been used. The quantities in excavations and embankments have been computed from the notes of this survey and may be considered to be close approximations to what the final quantities will be.

The total estimated cost of the two routes is as follows:

Item.	Northern route.	Southern route.
Excavation and embankment	\$69,898	\$140,367
Structures	347,425	216,966
Right of way and sites	35,926	16,382
Contingencies, 10 per cent.	45,325	57,412
Total	498,574	411,529

Difference, \$87,045.

Your estimates of June 21, 1890, made this total for the northern route \$491,252, and the increase here shown is entirely due to the increase in the estimated cost of right of way. The cost of excavation and embankment remains almost the same, while the cost of dams is decreased about \$12,000.

Very respectfully, your obedient servant,

L. L. WHEELER,
Assistant Engineer

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

Northern route, estimate of cost of excavation and embankment.

Item.	Cubic yards.	Price.	Amount.
Embankment north side Carr Island	6,891	\$0.15	\$1,033.65
Embankment across cut-off	4,510	.15	676.50
Embankment across north side Vandruft's Island	20,423	.15	3,063.45
Excavation Sears Canal (Hardpan)	51,156	.50	25,578.00
Embankment Sears Canal:			
Earth	16,435	.15	2,465.25
Rip-rap	1,208	1.50	1,812.00
Embankment Lock 36 to Turkey Island:			
Earth	59,084	.25	14,771.00
Riprap	13,244	1.50	19,866.00
Embankment on Turkey Island	8,350	.15	502.50
Embankment on north shore above Lock 37	866	.15	129.90
Total			69,898.25

Northern route, estimate of cost of structures.

Dam No. 2, 800 feet long, 8 feet high	\$21,835.00
Dam No. 8, 362 feet long, 18 feet high	51,745.00
Highway bridge (pivot)	5,800.00
Highway and single track railroad bridge combination (pivot)	25,400.00
Single-track railroad bridge (pivot)	23,800.00
Lock No. 36, 9 feet lift	103,154.00
Lock No. 37, 9 feet lift	44,635.00
Brush dams	65,000.00
Keeper's dwellings (2)	5,000.00
Fencing, 3.3 miles at \$320	1,056.00
Total	347,435.00

Northern route, estimate of cost of right of way.

Owner.	No. of acres.	Price per acre.	Total cost.
M. T. Johnson .....	.80	\$50	\$40.00
Hannah Newburg	9.47	.75	710.25
T. J. Robinson	14.85	200	2,970.00
Rock River Canal and Lock Company			*22,500.00
Sears Brothers			1.00
Graham's Cotton Mills			15,000.00
Graham & Co	1.17	1,000	1,170.00
Davenport estate	5.81	500	2,905.00
John Galliger	15.59	25	389.75
Phillip Dingleline	4.81	50	240.50
Total			35,926.50

* Includes old excavation.

† Rebuilding power house.

Southern route, estimation of cost of excavation and embankment.

Item.	Cubic yards.	Price.	Amount.
Embankment, Dam 1 to Dam 2	2,155	\$0.15	\$323.25
Excavation, guard lock to Mill Creek:			
Earth	50,970	.15	7,645.50
Rock	22,093	1.50	33,140.00
Embankment, guard lock to Mill Creek:			
Earth	14,330	.15	2,149.50
Embankment, Mill Creek to highway:			
Earth	132,800	.25	33,200.00
Riprap	14,850	1.50	22,283.50
Excavation, Mill Creek to highway:			
Earth	6,548	.15	982.20
Excavation, highway to Lock 36:			
Earth	55,929	.15	8,389.35
Embankment, highway to Lock 36:			
Earth	30,475	.15	4,571.25
Excavation, Lock 36 to Lock 37	123,843	.15	20,076.45
Embankment, Lock 36 to Lock 37	53,876	.15	8,081.40
Total			140,847.40

Southern route, estimate of cost of structures.

Dam No. 1, 530 feet long, 8 feet high	\$16, 463
Dam No. 2, 800 feet long, 8 feet high	21, 535
Guard lock	41, 801
Gulvert, 36 inches	2, 400
Waste weir, 100 feet long	1, 000
Highway bridge (pivot)	5, 800
Single-track railroad bridge (pivot)	23, 800
Lock No. 36, 6 feet lift	36, 170
Farm bridge	1, 000
Waste weir, 50 feet long	500
Lock No. 37, 12 feet lift	56, 500
Keepers' dwellings (3)	1, 440
Fencing, 4.5 miles, at \$320	1, 440
Total	216, 908

Southern route, estimate of cost of right of way.

Owner.	No. of acres.	Price per acre.	Total cost.
Luken & Beckwith .....	.82	\$100	\$82.00
Hannah Newburg	4.24	75	318.00
M. T. Johnson	8.97	75	672.75
John Tindall	18.40	75	1, 380.00
D. L. Cunkle			5, 000.00
Sears Brothers	4.10		72, 500.00
C. W. Mosher	13.60	100	1, 360.00
M. Gobel	3.89	60	233.40
The Hanson estate	13.52	60	811.20
The Vandruff estate	9.87	50	493.50
Peter Fries	28.00	50	1, 400.00
Swan Johnson estate	9.25	75	1, 193.75
David Beale .....	.11	50	5.50
Paul Hardnagel	8.22	50	411.00
A. Peterson	2.74	50	\$337.00
David Payne	3.18	50	159.00
Total			16, 362.10

*Milan water-power. †Including water-power rights. ‡\$500 damages demanded. §300 for buildings.

REPORT OF CAPTAIN W. L. MARSHALL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., March 19, 1891.

GENERAL: I have the honor to forward herewith a blue-print map of the vicinity of the mouth of Rock River showing the proposed locations (northern and southern) for the western 4 miles of the Illinois and Mississippi Canal.

The plans for this improvement submitted with my final report dated June 21, 1890, were based upon such data as had been secured by surveys made in 1882 and 1885, which data was lacking in other information, especially along the south shore of Rock River and in *levels*, even along the northern line.

As all the former surveys had been directed towards the northerly line, the plans based upon them necessarily followed the lines of survey.

Soon after beginning a detailed examination of the vicinity, more especially with a view of making detailed legal descriptions and plats of lands, etc., required for right of way, it was discovered that this vicinity had been the scene of many disastrous speculations dating back in their beginning a half century or more, and recurring at intervals to the present time, which have left a number of burned and ruined mills dams, lawsuits, and clouded titles, the latter especially along the northern bank in the vicinity of Sears Canal. It was also discovered that since the publication of the route as located on the submitted plans efforts were being made to clear titles, and to accumulate the needed

lands along the northern route in the hands of a few parties, as I believed with the intention of either demanding exorbitant prices for right of way, or to saddle upon the United States private water powers to be created and maintained by the United States forever, or to compel the United States to purchase this doubtful title to water-power rights at very remunerative prices, before this part of the canal could be built.

Search was then immediately begun for a second route around the lower rapids of Rock River that would comply with the law fixing the terminus of the canal at the mouth of Rock River. This has necessitated much work in the field and office not originally contemplated, and has delayed the commencement of the work by several months, but I believe to the great advantage of the Government, for such a route has been found probably 16 per cent. less costly than the northern or original route, and that more certainly enables us to carry 7 feet of water to the mouth of Rock River.

NORTHERN LINE.

The dams were laid out on the plans submitted near the locations of the dams as built by the water-power owners, but the present survey shows the impracticability, on account of the low site of the town of Milan, of building a dam of the necessary height across the south channel of Rock River at Milan.

The modified northern line is as follows: A dam across the south branch or channel at the head of Carr Island; the north channel of Rock River and Sears Canal to be followed; an embankment or levee above high water to be carried continuously on Carr and Vandruft Island to the head of Sears Canal, with a dam (18 feet high) 12 feet lift, to be built here across the north arms. A lock of $8\frac{1}{2}$ feet lift with two exits, (1) for medium to high, and (2) for low water service, with guard walls 7 feet above low water in the upper pool, to be built at the foot of Sears Canal.

Thence to the foot of Turkey Island a canal formed by an embankment in the river bed, and a levee on Turkey Island terminated by a lock of $8\frac{1}{2}$ feet lift near the foot of Turkey Island. Thence to the Mississippi River—a little more than a mile—an improvement by brush wing dams in the bed of Rock River. (I think this of doubtful practicability as the natural depth does not exceed 2 to 3 feet, the discharge of Rock River small (3,000 cubic feet per second*), and the bottom of sands).

SOUTHERN ROUTE.

Dams to be built 7 to 8 feet in height (on rock foundation, and of only 4 feet head of water against them), across both channels of Rock River at the head of Carr Island. The canal thence to the mouth of Rock River to be located on the south bank, either on the main land or on Big Island, with the exception of a section of canal built by embankment or embankments in the bed of Rock River from just above the mouth of Mill Creek to the head of Big Island, cutting off and closing the slough behind Big Island. The reason for this construction will be given hereafter.

Along the route there will be one guard lock at the head of the canal, one lock of 6 feet lift near the head of Silver Lake, and one lock "at the mouth of Rock River" of 12 feet lift. Silver Lake will furnish a deep and sufficiently commodious basin.

*It has been ascertained by subsequent measurements that the low-water discharge of Rock River does not exceed 1,500 cubic feet per second.—W. L. M.

One of the most important advantages of this line arises from the fact that there must be excavated from the prism of the canal a greater part of the riprap stone required for dams and embankments, also clean pit sand and gravel containing less than 3 per cent. of earth or soluble matter, and entirely free from carbonate of lime, *i. e.*, siliceous sand and gravel, so that, if it be allowed to build the masonry of artificial stone of Portland cement, the excavation of the canal prism will furnish all the material, and of the best quality of its class, except cement, for the construction of the locks, weirs, abutments of dams, and bridges. This fact, in view of the inferior quality of the magnesian limestones and sandstones accessible for building purposes, is well worth considering in connection with this route.

With reference to the southern line the only difficulty is in the disposition of Mill Creek, which enters the southern channel of Rock River a mile or less above the town of Milan. This stream rises back in the hills and bluffs, and being of steep slope and of sufficient watershed, is subject to sudden and rapid rises and brings down a great deal of sediment. At times of high water it overflows its banks and floods the low lands back of Milan, the overflow going towards the Mississippi.

The level of the banks at and below the mouth of Mill Creek is such that it is not advisable to take this stream into the canal, as, by backing it up, it might interfere with the drainage of lands, and would certainly be made the ground of claims for damages, whether justly or not, at every high water.

It is practicable to carry Mill Creek under the canal through invert, except possibly at extreme floods, when part of its discharge would have to be taken into the canal. In this case but *one* embankment would be required in the bed of Rock River from Mill Creek to the head of Big Island, and a second bank across Big Slough to form the canal.

The plan submitted, however, and shown in skeleton on the map herewith, is to form the canal by two parallel paved embankments in the bed of Rock River, leaving a channel way for Mill Creek to discharge through Big Slough into the Mississippi River.

It is not believed to be practicable to follow the northern route without either a long delay and litigation to get rights of way and quiet claims to water powers, or else, in shorter time, to involve the United States in a partnership or divided control over the discharge of Rock River. In the case of such partnership, or divided control, the United States will find themselves responsible for all expense for creating and maintaining a water power for private interests, and in the same position as elsewhere, notably at Moline, Ill., and on the Fox River, *i. e.*, unable either to modify their works if desirable without heavy damages, or to abandon them if at any time advisable to do so. Along this route the material necessary for the embankment, from the foot of Sears Canal to Turkey Island is a light loam and will therefore require either a much heavier bank or special precautions and expense to properly construct it; and finally, it is doubtful whether 7 feet of water can be obtained in Rock River near its mouth by wing dams and the method of contraction and scour.

On the other hand, along the southern route, the water-power dams are all broken down, the mills burned, and the claimants of the water powers have no rights derived from State charters or franchise of any kind. They have never had other than a squatter's right to the water, and moreover only two parties or claimants are to be dealt with. The

Lith. by A. HOEN & CO., Balto., Md.

United States district attorney gives me as his opinion that these parties have no claim to any water-power privileges that need be regarded by the United States unless they choose to attempt to obstruct the work of construction, when their rights may be determined judicially. We should not recognize their rights by dealing with them before beginning the works. They must prove their rights if they think they have any.

By the southern route, also, the full depth of 7 feet can be carried to the terminus of the canal "at the mouth of Rock River." We can carry this depth by the southern route, at reasonable expense, to the legal terminus; it is doubtful if it can be done by the proposed northern route.

For these reasons I have to respectfully recommend that the southern route be approved, but, irrespective of the above reasons, which in my opinion are sufficient to determine the question, the probable cost of the southern route is the less; it will give boat landings and facilities to the only town in this vicinity, Milan, and shipping facilities to a much larger extent to a rich agricultural vicinage, than the northern route, which cannot be approached with facility on account of the bluffs, mill lots, and low lands, from the head of the rapids to the Mississippi River.

I forward herewith the report of Assistant L. L. Wheeler upon the survey of the vicinity of the mouth of Rock River.

The estimates for the two works are as follows:

For the northern route as submitted by me June 21, 1890.....	\$491,272
As modified, as required by recent surveys	498,574
For the southern route.....	411,529
In favor of southern route.....	87,045

In view of the eight-hour law, and of the difficulty and dangers of constructing and protecting embankments built in the beds of rivers, I am inclined to think that all of these estimates are too low by 20 per cent., but in my opinion the *relative* cost of the two routes is probably correctly expressed by the estimates.

If the masonry can be built of artificial stone, which will hereafter be recommended, the locks may be increased in width to 35 or 36 feet, instead of 30 feet as ordered, and the bridges be made pivot, instead of fixed, without increased cost of the entire canal, or of the locks, to the great increase in utility of the canal.

This matter will be the subject of a separate communication to the Department hereafter.

Accurate descriptions of all lands required for the improvement along both routes have been prepared, and full abstracts of title to lands along the northern, or published route, have been nearly completed.

Voluntary agreements as directed by the law, in accordance with a form (herewith) drawn up by the United States attorney for the northern district of Illinois, are being prepared in this office for acceptance or rejection by the reputed owners of such lands in advance of the determination of the route, and it is hoped that in any event all lands requiring condemnation along either route may be brought before the district court at the ensuing spring term.

Very respectfully, your obedient servant,

W. L. MARSHALL,
Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 27, 1891.

CAPTAIN: Your report of the 19th instant on the survey of the proposed locations (northern and southern) for the western 4 miles of the Illinois and Mississippi Canal, with estimates of the cost of each, in which you recommend approval of the southern route, was duly received and submitted to the War Department with the following indorsement:

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 25, 1891.

Respectfully submitted to the Secretary of War.

Under the terms of the river and harbor acts of August 11, 1888, and September 19, 1890, providing for the construction of the Illinois and Mississippi Canal, this water way is to be constructed on such line as may be approved by the Secretary of War, and it is recommended that the proposed southern location for the western 4 miles of the canal be approved.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

The recommendation of this office has been approved by the Secretary of War under date of the 25th instant.

By command of Brigadier-General Casey:

Very respectfully, your obedient servant,

H. M. ADAMS,
Major, Corps of Engineers.

Capt. W. L. MARSHALL,
Corps of Engineers.

LETTER OF CAPTAIN W. L. MARSHALL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., May 7, 1891.

GENERAL: As the right of way for the construction of as much of the Illinois and Mississippi (Hennepin) Canal as the current appropriation of \$500,000 will pay for will probably soon be obtained, it is necessary to draw up the specifications for such parts of the work as may be best done by contract, and also for the material for masonry and such other work as may be best done by hired labor.

The river and harbor act of September 19, 1890, allows the Secretary of War to alter the dimensions of the locks, if the cost of the work is not increased thereby.

The approved dimensions of the locks are 170 feet long between miter sills, 7 feet deep, and 30 feet width.

It is not advisable to change the dimensions of the locks to diminish them, nor can they be increased, if of masonry, of cut stone, under the law.

Still it is very desirable that the locks be made wider than 30 feet. They should be 35 feet wide at least, for the following reasons:

(1) Such a width would allow the locks to accommodate the larger proportion of steamboats navigating the Upper Mississippi River, which can not enter locks of 30 feet width.

(2) The connection of the canal with the Great Lakes is by the Illinois and Michigan Canal, the boats of which are 97 feet long and 17 feet wide. The locks as designed will pass only one of these boats at a lockage, but if widened 5 feet will be doubled in capacity, and also take in a tug for towing them.

Now, the accessible stone for the construction of the locks of this canal is of inferior quality, the best being the magnesian limestone of Joliet, which absorb water and crack by frost, but nearly everywhere along the line of the canal is found a good quality of silicious sand and gravel, which by an admixture of the best quality of Portland cement will make an artificial stone which will be as hard as and better resist the action of the elements than the native building stones, and will be much more economically and strongly repaired, at an expense compared with natural stone, I estimate, in the ratio of 10 for the artificial to 17 for the natural stone.

In the excavation of the canal prism from the mouth of Rock River to the head of Milan Rapids, beds of purely silicious sand and gravel are met with, with only 3 per cent. of impurities, sufficient in extent, within the right of way, to construct the three locks, and much of the other masonry of that part of the canal. Native stone is excavated, which, broken, will furnish all the additional material needed.

It is very evident that if the canal prism excavation can be made to furnish all or even the greater part of the material needed, that a most economical condition is encountered.

With reference to the use of this material, artificial stone, for engineering constructions, I have to say that it is no longer experimental. I have to refer to the aqueduct for the supply of the city of Paris, France, with water; to the Liverpool Docks, England; to the Manchester Ship Canal, England; to the magazines and other masonry for our fortifications, some of which, as at Portland, Me., have been exposed for years to very rigorous climates; and finally to the Canal St. Denis, France, where near Paris a very important canal lock has been entirely coestructed of a rubble concrete, without a single cut stone being employed in its construction.

Moreover, I have to say, that I have built here in Chicago some 6,000 cubic yards of artificial stone for the public improvement of the Lake Michigan front of Lincoln Park, for the commissioners of Lincoln Park, and am familiar with its manipulation. This material has resisted three Chicago winters without frost cracks, and is now as sound as when laid.

I believe that this material should be more extensively used upon river and harbor works, especially where skilled labor is scarce—to hew stone and lay it up—and where good stone is difficult to obtain and expensive.

Now it is my belief—

(1) That all masoury on the Hennepin Canal can be built better and cheaper of artificial stone than of natural stone, in the ratio of cost of about 10 for the artificial to about 17 for the natural.

(2) That if the artificial stone is successful, there is a wide field for its use in river and harbor works elsewhere, at a very great saving to the United States.

(3) That if allowed on this work, that the locks can be increased in size from 30 feet in width to 35 feet in width, and that moreover all bridges may be made pivot or drawbridges instead of fixed bridges, and the canal can be made a ship or steamboat canal instead of a tow-path or barge canal, with animal power, and without increased cost

over the estimates already submitted, which estimates are based upon the use of cut-stone masonry.

I have therefore to respectfully request that the masonry of the three locks and the dam across Rock River be constructed of artificial stone of Portland cement, and as far as practicable of gravel, sand, and stone excavated from the prism of the canal.

The locks to be of 35 feet width, instead of 30 feet, but otherwise of the same dimensions and construction as heretofore submitted, and that the bridges be made pivot or draw, instead of fixed, with a view of extending this construction to the entire canal, should the experiment justify it.

I am, sir, very respectfully, your obedient servant,

W. L. MARSHALL,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., May 31, 1891.

CAPTAIN: Your letter of the 7th instant, recommending that the masonry of the three locks and the dam across Rock River on the line of the Illinois and Mississippi Canal be made of concrete, was duly received at this office and submitted to the War Department with indorsement, of which the following is a copy:

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
May 11, 1891.

Respectfully submitted to the Secretary of War.

The act of August 11, 1888, provides for the location of the Illinois and Mississippi Canal, with locks 170 feet long and 30 feet wide. The act of September 19, 1890, provides that the Secretary shall, in his discretion, change or alter the dimensions of locks of said canal and feeder, if, in his opinion, the cost of said improvement is not thereby increased.

Captain Marshall now recommends that the locks be made 35 feet wide; that the lock walls be made of concrete, using Portland cement and, so far as practicable, sand, gravel, and stone excavated from the prism of the canal. If constructed in this way, the cost of the locks will not be increased and Captain Marshall's proposition is recommended for approval under authority of the act of September 19, 1890.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

It has been returned approved by the Acting Secretary of War under date of May 11, 1891.

Your recommendation that the bridges across this portion of the water way be made pivot or draw instead of fixed, is also approved.

By command of Brigadier-General Casey:

Very respectfully, your obedient servant,

H. M. ADAMS,
Major, Corps of Engineers.

Capt. W. L. MARSHALL,
Corps of Engineers.

REPORT OF MR. L. L. WHEELER, ASSISTANT ENGINEER.

MILAN, ILL., June 16, 1891.

CAPTAIN: I have the honor to submit the following report upon measurements of bridges over Rock River in this vicinity, made with special reference to determining their capacity for permitting flood waters to pass. This information has been compiled mainly to determine what effect the closing of the south slough is liable to have on the remaining bridges and channels. Herewith are three maps showing the relative locations of the several bridges in the vicinity of Milan, with skeleton plan and elevation of each bridge and cross section of the channel way. A cross section of the whole valley at the Moline bridge is also shown. Views of the bridge are also shown. First of all a systematic effort has been made to determine the elevation and volume of the maximum flood resulting from head waters.

Every house in the valley between Milan and the mouth of Coal Valley Creek has been visited, and the residents questioned in regard to flood heights. Good determination of flood height at and below Milan were also made. Some well-defined marks were found and from these an approximation to high-water slope has been made.

The value of this slope above the rapids varies from 0.0002 to 0.0004, giving velocities varying from 5.8 to 8.1 feet per second. The elevation of high water of April 24, 1881, at the Moline bridge, seems to be well determined. The cross sectional area under this bridge below that high water is 11,976 square feet and outside the abutments 2,020 square feet. (See profile of valley at this point.) The area below high water at a point 1 mile above the Moline bridge is 13,000 square feet. It is probable that the volume of discharge outside the bridge abutments was not great, the flow being broken by fences, brush, and other obstructions.

It appears probable from this data that the maximum flow could not have exceeded 60,000. The Mississippi River Commission had parties at this time gauging the Upper Mississippi River. The flow at this time at Clayton, Iowa, just below the Wisconsin River, was about 70,000 cubic feet per second.

The flow at Hannibal, Mo., was about 270,000 cubic feet per second, or the amount furnished by the drainage area between Clayton and Hannibal was 200,000 cubic feet per second. This total area is 54,123 square miles, and that of the Rock River is 9,692 square miles. The flood of 1881 was the highest known in the Rock River, and was caused by a heavy body of snow melting suddenly under warm rains. The snow and rains were widespread and probably covered the entire drainage area between Clayton and Hannibal. Allowing for the fact that the maximum floods in the several tributaries would not occur at the same time, and taking into consideration the relation of the Rock River drainage area to the whole area, it seems very probable that Rock River did not contribute more than one-third of the difference of discharge between Clayton and Hannibal, or about 67,000 cubic feet per second.

This discharge would correspond to a velocity of less than 6 feet per second under the Moline bridge.

The following table shows the area under each bridge below the lowest member thereof.

Bridges over Rock River.

Bridges.	No. of spans.	Length of spans.	Total length.	Elevation of lowest member.	Area.
	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Sq. feet.</i>
Rock Island and Peoria Railway:					
No. 1, from Milan.....	2	135	270	135.2	3,574
No. 2, from Milan.....	3	135	408	133.4	5,521
No. 3, from Milan.....	3	155	465	137.0	9,251
Wagon bridges:					
No. 1, from Milan.....	2	139	278	134.1	3,508
No. 2, from Milan.....	1	137	137	133.5	1,758
No. 3, from Milan.....	3	1-40 2-103	260	132.5	3,093
No. 4, from Milan.....	2	157	315	135.5	6,146
Moline wagon bridge*	5	1-47 4-162	701	142.5	13,767

* Discharge area at high water, 11,976 square feet.

From this table it will be seen that after closing the south slough the two remaining railway bridges have an area exceeding the high-water area under the Moline Bridge by 2,796 square feet. As the bed slope is much greater at the railroad bridges than at Moline Bridge, the velocity would be greater were it not for the back water from the Mississippi River, which would tend to reduce the current and increase the height. Several determinations of high-water marks above the dams make an elevation of about 133.8, while determinations of back water vary from 131.2 to 131.6.

To pass the maximum discharge of 67,000 cubic feet per second under the two remaining railway bridges would require a velocity of 4.54 feet per second. The area of the three remaining wagon bridges is 10,997 square feet or 977 square feet less than the high-water area under the Moline Bridge, and requires a velocity of 6.1 feet per second to pass the maximum flood.

All the bridges are too low, but in the case of the wagon bridges this can readily be remedied by raising them bodily a couple of feet and grading up to them. All the piers and abutments are on bed rock and are probably safe from undermining. Most of the piers and abutments are protected by riprap at their bases. It is believed that the piers of the Moline Bridge are founded on mounds of riprap. The wagon bridge between Big Island and Hakes Island reduces the width of that channel very materially. It should have been nearly twice its present length. In regard to the capacity of the bridges to pass the maximum run of ice, I have to say that, so far as I can learn from the residents of the vicinity, the ice does not run at the highest floods and that the south slough has small capacity as an ice carrier. Its mouth is choked with willows and broken up into several channels and the ice soon gorges and closes the channel. This was the case this last spring.

It is believed that the closing of the south slough will diminish instead of increasing the danger from running ice when the movement takes place at anything below ordinary flood stage.

From Penny Slough to head of rapids near Milan there is but one channel, and when ice is running the depth of water is probably sufficient to carry the ice without gorging.

Carr Island divides the river into two channels with a total width of from 1,300 to 1,500 feet, and the depth is correspondingly decreased. At the foot of Carr Island the two channels are connected by a narrow but deep channel. Mill Creek enters from the south just opposite this channel. Below this point where it is proposed to narrow the channel, the channel widens out and finally is separated into three channels by Hakes and Big Islands. Just above these islands the south channel is 1,200 feet wide and the north channel 400 feet. When the area of this section is equal to the high-water area at Moline Bridge the stage would be 130.5 feet. The water in south channel would be 6.5 feet deep and 7.5 below proposed grade of the top of the outer embankment. It appears from the information furnished by Mr. John C. Johnston that the maximum stage at mill on Milan front is 133.25 (see following table). It is not surprising, then, that in this vicinity the ice should frequently gorge, and this very liability of one or more of the channels gorging and throwing all the ice on the remaining channel is a great element of danger.

Could all the water be conducted down one channel of sufficient capacity for the flood volume it is very probable the ice would do less damage than at present.

It is believed, therefore, that closing the south slough will not increase the danger to the bridges either from floods or ice, unless the stage should be so high as to cause ice and drift to strike the lowest members.

All the old maps and statements of old inhabitants agree in placing in the south channel, on the Milan front, sometimes in one position and sometimes in another, one or more sand bars or islands.

This simply means that the channel is wider than required for the flow of the stream, and this greater width has probably been caused by the partial closing of the existing channels by ice.

It has been the custom of Sear's Sons to put flush boards on their dam as the ice was breaking up and by that means prevent the ice going over their dam and forcing it to take the south channel.

Last spring the ice did not run in the north channel, but a large amount of it went north of Carr Island and returned to the south channel by the cut-off.

The south slough was entirely closed by the first run of ice.

The following table gives the elevations of high water as determined:

Data in regard to high-water marks in vicinity of Milan.

Elevation.	Distance from Mississippi River.	Date.	Authority.	Remarks.
<i>Feet.</i>	<i>Miles.</i>			
142.37	8.2	Probably 1881.....	Fanny Killing.....	Doubtful; no definite mark.
141.01	7.8	.....do.....	F. G. Mason.....	Cut in tree.
139.86	7.0	April 24, 1881.....	B. P. Oakley.....	Definite.
136.83	5.5	Probably 1881.....	Wm. Harrold.....	Do.
133.76	3.3	.....do.....	Thos. Gannon.....	No definite mark.
131.25	3.2	.....do.....	Jno. Johnston.....	Definite.
131.44	2.0	May 14, 1888.....	W. F. Tengus.....	Back water definite.
131.14	2.4	May, 1888.....	Merritt Gobel.....	Do.

It will be noticed on the index map of bridges near Milan that there is an old water-power canal on the north side of Hakes Island. It is probable that in part it occupies part of the original river bed, and is something of an obstruction to the flow of the stream. The mills are burned and the dams destroyed and it may well be doubted if they ever will be rebuilt. The water way of that channel could be materially increased by removing the side of the canal and the wreckage which partly closes it and building a short-span wagon bridge over the channel thus made. If thought advisable a second span could be put over the channel between Big Island and Hakes Island without interfering with the canal.

Very respectfully, your obedient servant,

L. L. WHEELER,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

ANNUAL REPORT OF MR. L. L. WHEELER, ASSISTANT ENGINEER.

MILAN, ILL., June 30, 1891.

CAPTAIN: I have the honor to submit the following report upon the work on the Illinois and Mississippi Canal for the fiscal year ending June 30, 1891:

The river and harbor act of September 19, 1890, appropriates \$500,000 for this work, but work did not commence until November 17 following. I came to Milan October 22, and, while waiting orders, thoroughly examined the vicinity of the proposed works and prepared for making surveys covering the entire locality. The weather proved exceptionally fine during the winter and good progress was made with the surveys. A tertiary system of triangulation was measured from the head of Carr Island to the Mississippi River, duplicate lines of levels run on each bank, numerous bench-marks set and the islands and shores covered with stadia elevations. Soundings were taken in Rock River below the rapids and a hydrographic survey made of the Mississippi River near the mouth of Rock River. Since submitting my report on the proposed routes, March 7, 1891, the surveys have in part been carried up the river about 4 miles above Carr Island.

The valley of Rock River at this point is about $1\frac{1}{4}$ miles wide and evidently is the old bed of a stream of much larger volume than that now flowing in it.

The hills on either side rise quite abruptly, the present river bed being along the hills on the north side until the alluvial valley of the Mississippi is reached. The river is divided by islands into several channels, one branch leaving the main stream at Milan and entering the Mississippi by a separate mouth. The rapids commence at the head of Carr Island and extend downstream about $1\frac{1}{4}$ miles, the total fall at extreme low water being about 12 feet. High water of the Mississippi is about 5 feet higher than low water at the head of the rapids. The discharge of the stream is not known to me, but probably varies from 2,000 to 50,000 cubic feet per second. The extreme maximum flow may reach 65,000 to 70,000 cubic feet per second. The bed-rock of the valley is limestone, very much seamed, and broken and worthless, except for riprap and concrete. There is no stone suitable for masonry in the immediate vicinity. In the valley the rock is overlaid by from 1 to 10 feet of clay and sand and in some places by very clean sand and gravel. In the hills the limestone is overlaid by the strata of the Carboniferous age. Coal mining is one of the industries of the vicinity and excellent fire clay abounds.

The fall in the river early attracted the attention of parties interested in water-power, and dams and mills of various kinds were built. The State of Illinois constructed a canal by the rapids at an early day and private parties at a later date constructed a canal of considerable proportions known as Sears Canal. The canals for navigation purposes long since passed into decay, the mills are in ruins, except two, and most of the dams are destroyed. Sears Canal and a dam across the north channel furnishes water-power to one small cotton factory and one paper mill. The dam is in a very dilapidated condition and in all probabilities will not be able to withstand a run of ice over its crest. So much water passes through the dam that the head is very materially reduced and at low water there is none available for the paper mill.

On June 21, 1890, a project for carrying the canal by the rapids at this place, based on preliminary surveys, was reported on by yourself and is published in the Report of the Chief of Engineers for 1890. This project proposed to build the dams across the several channels on substantially the same lines as the old dams, to pass through Sear Canal with a lock at the lower end, thence by a canal in the river bed along the right bank to the foot of Turkey Island. At this point was to be placed a lock giving entrance into the main stream, which was to be deepened by means of wing dams and dredging. The more detailed surveys showed that this project would re-

quire some modifications. The south shore was found to be too low to permit raising the water against it to the proposed level, and the dams would require to be much higher and more expensive than had been supposed. That project was therefore modified by putting the dam across the south channel at the head of Carr Island and estimating for building levees on the north shores of Carr and Vandruff Islands, and for closing the channel between those islands. These changes decreased the estimated cost of the dams about \$12,000.

It was found, however, that the prices demanded by the property owners along that route would largely increase your estimate of the cost of right of way, which was \$1,250. Taking into account the enormous benefits the owners would derive from the construction of the canal and the rebuilding and maintaining their water-powers and the small amount of land required under that project, that amount would seem to be a fair compensation for the land to be taken. The line through Sear Canal was followed partly because it was supposed that the work already done there would save some cost. This canal was constructed by the Rock River Canal and Lock Company, which held a deed to part of the land, for navigation purposes only, from the Rock River Navigation and Water Power Company. All interests of the latter company had been sold under execution to David Sear's Sons. The canal had long since been abandoned for navigation; a railroad embankment had been graded across it and the lock fallen into ruins. After the work of surveys commenced representatives of the defunct companies appeared and demanded \$22,500 for the right of way through the canal. My estimate of the cost of right of way based on the statements of such of the owners as would name any price was \$35,926; but when formal agreements came to be signed four owners demanded a total of \$75,449, or more than one-seventh the total appropriation, while the owners of water-power and mills along Sear Canal failed to sign any agreements at all. It is evident, then, if that route was to be followed large sums must be expended to satisfy the claims of the owners, or tedious litigation gone through to secure title to the needed lands.

The available room to carry the proposed canal along the line of Sear Canal is very restricted and poorly adapted to the needs of commerce. In the short space of one-half mile it would be necessary to construct a highway bridge, a railroad bridge, a combined highway and railroad bridge, a lock, a sharp curve in the canal, and to provide for transmitting power to the cotton factory. Aside from these facts, the route on the north side as modified did not give the people of the locality any shipping facilities whatever without passing over private lands.

The results of the general survey of the locality which had been made showed that a feasible route existed along the south shore, although all preceding projects had proposed using the north shore. This route leaves the river at the head of Carr Island by a guard lock, and down to Mill Creek the canal section is entirely on the main shore. This shore is a stable one, the original meander stone of the United States Land Survey being still in place on the range line. From Mill Creek to upper end of Big Island it is proposed to carry the canal in the river bed by two parallel embankments, the branch of the river flowing south of Big Island being entirely cut off from the main stream and left as a channel for Mill Creek and such water as may be sent down it by sluices built for that purpose. From the head of Big Island to the mouth of Rock River the canal is entirely on land and presents no engineering difficulties. On the contrary it presents great advantages in having good material for mortar and concrete in the immediate vicinity of the proposed locks and in taking the required depth to the *Mississippi River* in marked contrast to the northern route, which leaves about 1 mile over which the required depth would have to be obtained by means of wing dams and dredging.

It also presents the following quite important advantages: (1) It passes through farming lands which can be obtained at reasonable figures and which have not been subject to wild-cat speculations and the consequent clouding of titles. (2) It will be bordered a large part of its length by a public highway, giving to the public ample shipping facilities. (3) It can be constructed without placing the United States in a position of being compelled to purchase decayed water-powers or to enter into relations with the owners which would prove expensive and unsatisfactory in the end.

Before deciding upon the southern route as outlined above an effort was made to arrive at some understanding with land and water-power owners by which the necessary lands could be obtained for leaving the river at the head of Big Island and building the dams on substantially their present lines, except that across South Slough which was to meet the left bank above Mill Creek. This project would have rebuilt all the water-powers, much to the benefit of the owners and the locality. The owner of the Milan water-power refused to do anything but to sell his interests for \$30,000; the owners of Vandruff Island made a proposition which left entirely unsettled all damages to that island from raising the water level, and therefore could not be considered, and the remaining owners of water-power ignored the matter entirely. There was, then, nothing to do but to follow the route as outlined above and leave the development of the water-powers to the owners thereof. This project

neither builds nor destroys water-powers, but it does make it possible for the powers on the north channel and on the Milan front to be rebuilt and improved at comparatively small expense.

My estimate of cost of right of way for the southern project was \$16,326, and agreements since signed by 11 owners would indicate that this estimate would not be largely exceeded. The owners of 4.1 acres at the head of Big Island doubled their price, making it \$5,000, after they learned the southern route had been adopted.

On March 7, 1891, I submitted to you a report on the two routes and estimates of the cost of the same. These estimates were based upon the same prices and were intended to be entirely impartial, and to give a fair comparison of the relative cost of the two projects. The estimates as submitted with that report are herewith, the total for the northern project being \$498,574, and for the southern project \$411,529, showing a difference in favor of the southern project of \$87,045. The southern project was recommended by yourself and by the Engineer Department for adoption, and on March 25 was formally approved by the Secretary of War. The description of needed lands on both routes required considerable labor. For this work a local surveyor, Mr. C. H. Stoddard, who had long been a resident of the county and was familiar with the land lines, was employed. All courses and distances, however, were checked by entirely independent measurements. After the descriptions and plats of required lands were completed, agreements were prepared and submitted to the property owners with the request that they state the price asked for the lands described. With two exceptions propositions were received from owners on the southern route, but three of those received I consider named prices above the market values of the land. The larger part of the right of way can be obtained at prices varying from \$50 to \$100 per acre, which is about the value of the lands for agricultural purposes. From the north side but two reasonable propositions were received. The owners of Vandruff Island demanded \$50,000 for 14.85 acres, worth about \$50 per acre; the claimants to Sears Canal demanded \$22,500 for their interests in that boatless canal; the owner of Turkey Island demanded \$125 per acre for land worth about \$12.50, while, as before stated, from the principal owners of the lands and water powers along Sears Canal no propositions whatever were received.

Since the approval of the route by the Secretary of War the canal section and embankments have been staked out on the ground, some minor changes in alignment made, careful cross sections taken, and a second estimate of the earthwork made from these notes which did not materially differ from the first estimate submitted.

The officials of the Rock Island and Peoria Railway having raised the question that the partial closing of South Slough would endanger their other two bridges, careful measurements of all the bridges over Rock River in the vicinity were taken and maps showing the bridges in plan and elevation drawn.

A systematic effort was also made to determine the elevations of the highest waters.

Accompanying this report is a map of the locality on which is shown the route as approved. The station numbering commences at the Mississippi River, and the terms right and left are used following the order of station numbering. It is proposed to enter the canal from the river by means of Lock 37 of 12 feet lift at low water. The lock would be entirely backed out at high water. On the right bank it is proposed to raise the embankment to grade 134 the whole length of the canal, except between the railway and highway, where it will be 138, but part of the distance the natural elevation is such that no embankment is necessary. The left embankment it is proposed to raise to grade 127 as far as Lock 36. Lock 36 has a lift of 6 feet, but at high water would be backed out. The left embankment above Lock 36 is to be at grade 134 as far as Station 146, between which point and the railway it raises to grade 138 and keeps that grade to the guard lock. In the embankments and at the guard lock it is proposed to put the necessary sluices and weirs to regulate the levels and the flow of water down the South Slough. The material to be excavated and the proposed levels are shown on the profile of the center line. The cost of structures as far as possible were taken from your report of June 21, 1890. The following gentlemen have assisted me in the field and office work: Charles Francis, C. H. Stoddard, F. S. Hunter, R. B. Stearns, J. W. Woermann, and Charles L. Woodbury.

Very respectfully, your obedient servant,

L. L. WHEELER,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

NOTE.—The estimates of cost of construction, right of way, etc., are attached to Mr. Wheeler's report of March 7, 1891, and are therefore omitted from this.

JOINT RESOLUTION OF SENATE AND HOUSE OF REPRESENTATIVES OF THE STATE OF ILLINOIS, GIVING ASSENT TO THE UNITED STATES TO ACQUIRE TITLE BY PURCHASE OR CONDEMNATION TO ALL LANDS NECESSARY FOR THE CONSTRUCTION AND MAINTENANCE OF THE ILLINOIS AND MISSISSIPPI CANAL.

ILLINOIS AND MISSISSIPPI CANAL.

Be it resolved by the senate and house of representatives of the State of Illinois, That the assent of the general assembly of the State of Illinois be, and the same is hereby, given to the United States to acquire title to, by purchase or condemnation proceedings in accordance with the laws of the United States and of this State, and to hold, occupy, and possess all lands necessary for the construction and maintenance of the Illinois and Mississippi Canal and the feeder thereto, as provided for by act of Congress entitled "An act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," approved September 19, 1890; and the State of Illinois hereby cedes to the United States jurisdiction over any and all lands so acquired.

CLAYTON E. CRAFTS,
Speaker of the House of Representatives.
LYMAN B. RAY,
President of the Senate.

Introduced in the Senate.

L. F. WATSON,
Secretary.

UNITED STATES OF AMERICA,
State of Illinois, ss:

OFFICE OF SECRETARY.

I, Isaac N. Pearson, secretary of state of the State of Illinois, do hereby certify that the foregoing is a true copy of senate joint resolution concerning the Illinois and Michigan Canal, filed in this office April 30, 1891, the original of which is now on file in this office.

In witness whereof I hereto set my hand and affix the great seal of State at the city of Springfield this 30th day of April, A. D. 1891.

I. N. PEARSON,
Secretary of State.

M M 7.

PRELIMINARY EXAMINATION OF ILLINOIS RIVER, ILLINOIS, FROM LA SALLE TO THE MISSISSIPPI RIVER, WITH A VIEW TO ASCERTAINING LANDS SUBJECT TO OVERFLOW BY THE CONSTRUCTION OF WATERWAY BETWEEN LAKE MICHIGAN AND THE MISSISSIPPI RIVER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., January 15, 1891.

GENERAL: I have to respectfully report concerning the item contained in the "act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," approved September 19, 1890, relating to a survey of the Lower Illinois River, as follows:

ILLINOIS.

Illinois River from La Salle to the Mississippi River, as recommended by Capt. W. L. Marshall, Corps of Engineers, in his report dated March ten, eighteen hundred and ninety, with a view to ascertaining what lands would be subject to overflow by the construction of a navigable water way between Lake Michigan and the Mississippi River, but not more than twenty-five thousand dollars of the money appropriated for surveys shall be allotted to this river.

I have to say that as far as any "navigable water way" recommended by this office is concerned, which work is now in progress and nearly completed on the Lower Illinois River, that there will be practically little or no lands overflowed or flooded, and that it is thought that the surveys already made are sufficient.

I have further to report that it is thought that this item is based upon the following paragraphs of the report upon the "survey of a water way from Lake Michigan to the Illinois River at La Salle," published as House Ex. Doc. No. 264, Fifty-first Congress, first session, relating to a constant discharge from Lake Michigan into the Illinois River for sewage disposal purposes, of from 300,000 to 600,000 cubic feet per minute, on page 33 of that document:

This artificial discharge is not *necessary* for navigation anywhere along the line, and can not be said to *benefit* navigation anywhere to such an extent as to justify the United States Government assuming responsibility for flowage damage caused by it. * * *

At any little summer freshet, producing a discharge exceeding 8,000 cubic feet per second, at La Salle, damage by overflow would begin at that point, the artificial discharge being 10,000 cubic feet per second, and with greater natural discharge become more and more widespread as we progress downstream at times when such overflow would not otherwise occur.

From 100,000 to 300,000 acres of lands in the Illinois Valley will be subject to such conditions. * * *

That feature, therefore, in the Chicago drainage and water-way laws that requires a *constant discharge* of from 300,000 to 600,000 cubic feet per minute seems, in view of past experience, decidedly objectionable, if the water is to be introduced through any canal either owned or used by the United States for public purposes, if by such ownership or use the United States can be made responsible for damages due to such constant discharge. * * *

As the State law stands, however, demanding a constant discharge and unnecessarily great and expensive channels neither demanded by nor suitable for the commerce to be subserved, a compliance with its terms does not seem advisable for the United States.

In view of these facts and laws (Chicago drainage laws) a thorough survey from Joliet to the Mississippi River, at least with the detail shown on the maps of the present survey, i. e., with accurately determined contours at every foot elevation of surface, and with the areas of land subject to overflow well determined, should be made by authority of Congress, before any artificial discharge whatever is turned into the Illinois River, to determine the effects of such artificial discharge and the areas of lands that may be subject, under any conditions, to flowage thereby. Such a survey would cost probably \$250,000, but ultimately save many times that amount to the organization held responsible for such flowage damages, whether it be the Government of the United States or the city of Chicago.

As the survey recommended by me covers a length of the Illinois River of some 290 miles of bottom lands, densely timbered over a major part of it, and including some 500 square miles or more of area of swamps, lagoons, timbered, and cultivated lands, the amount appropriated (\$25,000) is utterly insufficient to secure the information required and can not be expended to good purpose if confined to the survey of the character recommended by me in said report, and spread out over that area.

The Illinois River is worthy of improvement, and its improvement is now in progress. The survey as recommended by me should also be made as a protection for the United States against claims for damages for overflow by water turned into United States channels and over United States dams proposed by the Chicago sanitary district, but the amount appropriated is not more than one-tenth of the amount required to make such survey.

There is certain work, however, that may be done with the amount

appropriated that could form part of a complete survey as recommended, and at the same time be of advantage to the improvement of the Illinois River as now being executed by the United States Government, viz:

(1) A line of precise levels from Grafton, near the mouth of the Illinois River, connecting there with the work of the Mississippi River Commission to Lake Michigan, via the Illinois River Valley and the Chicago Divide, with numerous permanent bench marks in the Illinois River Valley as points of departure for the detailed contoured maps recommended.

(2) Any excess of funds over and above what is necessary for this line of precise levels to be applied in making a hydrographic survey of the United States pools created by the dams at La Grange and (when completed) Kampsville, Ill., to ascertain the amount of dredging required to complete the present project of improvement.

A further appropriation of \$225,000 to complete the survey recommended by me will be necessary.

Very respectfully,

W. L. MARSHALL,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, January 20, 1891.

Respectfully forwarded.

I concur in the views of Captain Marshall, and recommend that he be authorized to apply the appropriation in the manner proposed by him.

O. M. POE,
*Colonel, Corps of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer, Northwest Division.*

SURVEY OF ILLINOIS RIVER, ILLINOIS, FROM LA SALLE TO THE MISSISSIPPI RIVER, WITH A VIEW TO ASCERTAINING LANDS SUBJECT TO OVERFLOW BY THE CONSTRUCTION OF WATER-WAY BETWEEN LAKE MICHIGAN AND THE MISSISSIPPI RIVER.

[Received with letter of Capt. W. L. Marshall, Corps of Engineers, dated July 10, 1891, page 2595.]

This work was directed by the river and harbor act of September 19, 1890, in the following terms:

SEC. 17. That the Secretary of War is hereby directed, at his discretion, to cause examinations or surveys, or both, to be made and the estimated cost of improvement to be estimated at the following location, to wit:

* * * * *

"ILLINOIS.

* * * * *

"Illinois River, from La Salle to the Mississippi River, as recommended by Captain W. L. Marshall, Corps of Engineers, in his report dated March ten, eighteen hundred and ninety, with a view to ascertaining what lands would be subject to overflow by the construction of a navigable water way between Lake

Michigan and the Mississippi River, but not more than twenty-five thousand dollars of the money appropriated for surveys shall be allowed to this river."

The recommendation contained in the report cited was as follows:

In view of these facts and laws (Chicago drainage and water way laws) a thorough survey from Joliet to the Mississippi River, at least with the detail shown on the maps of the present survey, i. e., with accurately determined contours at every foot elevation of surface and with the areas of lands subject to overflow well determined, should be made by authority of Congress before any artificial discharge whatever is turned into the Illinois River to determine the effect of such artificial discharge and the areas of lands that may be subject under any conditions to flowage thereby. Such a survey would cost probably \$250,000, but ultimately save many times that amount to the organization held responsible for such flowage damages, whether it be the Government of the United States or the city of Chicago.

As the estimated cost of this survey is \$250,000, and the act limits the expenditure to one-tenth of this amount for the contoured survey of from 500 to 750 square miles of territory, densely timbered, swampy, covered with lagoons, and in many places nearly impenetrable, it can at once be seen that the object of the survey can not be met to any extent by this small sum.

As far as any project by United States officers for a water way via the Illinois River is concerned the damages by flowage are already known to be insignificant and that no further surveys to determine them are needed.

For such a water way as contemplated under State laws ten times the amount appropriated, at least, is necessary for results of value in suits for damages.

The amount allotted can be expended to advantage in carrying a line of precise levels from the Mississippi River to the Great Lakes, connecting with the levels of the Mississippi River Commission, to serve as a basis for the survey indicated, also in making an hydrographic survey of the pools of the Illinois River to ascertain the amount of dredging required to complete the existing project of improvement and to form part of the more extended survey.

Before making such uses of this fund it is judged advisable to further submit the matter to Congress in order that such use may be authorized or proper funds be allotted for the survey of the alluvial lands of the Illinois River Valley subject to overflow, or an indication that annual appropriations will be made for the continuance and completion of such a survey as recommended.

M M 8.

ESTABLISHMENT OF HARBOR LINES IN CHICAGO HARBOR, ILLINOIS.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., September 17, 1890.

GENERAL: The Board of Engineers constituted by Special Orders No. 61, dated War Department, Corps of Engineers, U. S. A., Washington, D. C., September 11, 1890, respectfully submit the following report:

The Board met as directed, at the United States engineer office, Chicago, Ill., where, after the order convening the Board and the instructions of the Department were read, the maps and records of the harbor were consulted and the reports of the Boards of Engineers con-

vened heretofore in 1871 and in 1882 upon the same or similar subject, were examined.

Later a public meeting, which had been previously advertised in the Chicago daily papers, was held at the Director's rooms of the World's Columbian Exposition to hear statements from all persons who desired to be heard upon the subject before the Board at this meeting and a subsequent one held next day. All parties interested in the establishment of dock and harbor lines and in the use of the submerged lands within the harbor inclosure who desired were heard or presented written documents.

The instructions under which the Board acted are as follows:

It is directed that the Board of Engineers constituted by Special Orders No. 61, Headquarters, Corps of Engineers, September 11, 1890, to consider and report upon the subject of harbor lines (pier and bulkhead) at Chicago, Ill., shall hold such public meetings as may be necessary and afford a reasonable hearing to all interested parties who desire to present their views upon the subject under consideration.

It is also directed that the Board submit for consideration of the Secretary of War its recommendations as to the location of pier and bulkhead lines to be established under the provisions of section 12 of the river and harbor act of August 11, 1888.

The Board interpret their instructions as limiting their duties to the recommendation for the establishment, by the Secretary of War, of harbor lines under the act of August 11, 1888, for the protection and preservation of the outer harbor at Chicago, "beyond which no piers or wharves shall be extended or deposits made, except under such regulations as may be prescribed from time to time by him," and that it is not to consider questions relating to any proposed uses of any of the now submerged lands lying between the dock or harbor line so recommended for establishment and the present shore line.

The construction of this harbor basin was commenced in 1871 and was practically completed, except dredging, by 1881. In 1871 a Board of Engineers, composed of Lieut. Col. I. C. Woodruff, Maj. G. K. Warren, and Maj. D. C. Houston, Corps of Engineers, recommended the establishment of a dock line, which recommendation was approved by the Secretary of War October 4, 1871, as follows:

The Board is of the opinion that an open space of not less than 1,200 feet west of the breakwater north of the north line of Randolph street and 2,000 feet west of the breakwater south of that line is sufficient for the purpose of a roadstead, and would recommend that a line commencing at a point on the south side of the United States south pier and 1,200 feet west of the west line of the breakwater, and running due south till it intersects the prolongation of the north line of Randolph street, thence due west 800 feet, thence due south till it intersects an east and west line through the south end of the breakwater as at present designed, be established as the harbor line, beyond which no wharves or other structures shall extend.

This harbor line as established in 1871 and adhered to since that date terminated southward opposite the present end of the easterly breakwater, just north of the present east entrance to this outer harbor basin, at which point the harbor as then designed terminated. Since that date the easterly breakwater has been further extended and the harbor, instead of having its southerly limit between Van Buren and Congress streets of the city of Chicago, extends as far south as to between Twelfth and Thirteenth streets of the city.

There have been no reasons presented to the Board for any change in the position of the harbor line as far as it has been established, nor for a change of direction of this line southward from Van Buren street. The reasons given by the Board of Engineers of 1871 for the location of

the harbor line as far as Van Buren street still hold good, and are applicable to the extension of this line southward throughout the limits of the harbor.

The Board therefore recommend the following harbor line for adoption:

Commencing at a point on the south side of the United States south pier of the entrance to Chicago River and 1,200 feet west of the west line of the easterly break-water, outer basin, and running due south till it intersects the prolongation of the north line of Randolph street, thence due west 800 feet, thence due south to the southern limit of the outer harbor.

The Board was directed to hear statements from all parties interested in the subject before it, and under the invitation issued by the Board a number of verbal statements and written documents relating to the proposed use for World's Fair (1893) purposes of the submerged lands lying between the proposed harbor (pier and bulkhead) lines recommended and the present shore line were presented to the Board, which are appended hereto, with the minutes of the proceedings of the Board.*

Although these statements and documents relate to a subject that does not seem to come within the province of the Board as outlined in the letter of instructions, they have arisen from the action of the War Department under the recommendations of previous Boards of Engineers in 1871 and 1882, and the Board considers that it may not be improper to remark upon the matter also.

In 1871 the Board of Engineers, in establishing the harbor line beyond which no wharves or other structures should be built, which line is now recommended to be extended southward throughout the limits of the outer basin, made a recommendation to the Secretary of War, as follows:

As to the question of ownership to the land on the shore from the north line of Randolph to Madison street is now in the United States circuit court of the northern district of Illinois, on a complaint made by the United States, to which answer was made by the president of the Illinois Central Railroad Company in December, 1869, it would seem proper that no piers should be allowed to be built there until a settlement has been made. Besides the interests of commerce and navigation, there are local matters affecting the legitimate use of the basin, which should be controlled by the city. After all questions of rights along the lake shore have been disposed of, whoever may be entitled to build piers, if such a right exists, should then be required to submit his plans to the Engineer Department for approval; until that time all parties should be prohibited from filling up any part of the basin now being formed outside of the present line of piling made to protect the track of the Illinois Central Railroad Company.

This recommendation was approved by the then Secretary of War, Mr. Belknap, October 4, 1871 (see Report Chief of Engineers, 1882, page 2237), and this prohibition against any construction between the harbor line and shore line south of Randolph street and north of Park Row has been since adhered to, as shown herein below.

In 1882 the Illinois Central Railroad Company desired to widen their right of way by building a bulkhead farther out than their shore protection, and filling in between it and the then shore line with earth or other material, and this matter was referred to a board of engineers, composed of Lieut. Col. John G. Parke, Lieut. Col. C. B. Comstock, and Maj. G. Weitzel, Corps of Engineers. The report of this Board is to be found on page 2234, *et seq.*, Report Chief of Engineers, U. S. A., 1882.

In commenting upon this report and in acting upon the recommendations contained therein the then Secretary of War, Mr. Lincoln, uses

* Not printed.

the following language (Report Chief of Engineers, 1882, pages 2231-2232):

A further report * * * , with all the previous papers, was * * * submitted to the Attorney-General of the United States * * * . In due time the Attorney-General returned the papers to the Secretary of War, inclosing a communication from the United States attorney for the northern district of Illinois, who was of the opinion that the title to the soil under the waters of Lake Michigan, up to the line of the shore, has, since the admission of the State of Illinois into the Union, been in said State, and so remains unless a valid grant of the same can be shown * * * . The Attorney-General, in transmitting the opinion of the United States district attorney, advised the Secretary of War that—

"The question whether the ownership of the soil is in the company or elsewhere (the United States asserting no title thereto) appears to me to be unimportant in so far as the General Government is concerned, and that the only inquiry which need be entertained by your Department is whether the construction of the 'dock line' [Illinois Central Railroad] will obstruct, encroach upon, or interfere with the harbor improvement, and thus injuriously affect its usefulness in the interests of navigation."

It is considered that it will be premature for this Department to approve any plan for the construction or beginning the construction of wharves in the harbor of Chicago until the title to the submerged land upon which they must be built shall be judicially settled. The plan proposed in the report of the Board of Engineers being, in fact, a plan for the beginning of such wharves upon conditions not within the power of the War Department to impose, and the title of the land being still in dispute, is therefore disapproved, and the prohibition now resting against the extension of the present railroad breakwater will be continued.

The suit to determine the ownership of the submerged land, and of the riparian rights of accretion, dockage, and wharfage, is still undecided. The United States is not one of the claimants to these rights south of the old Fort Dearborn addition (Madison street), but these rights are claimed by—

- (1) The State of Illinois;
- (2) The city of Chicago; and
- (3) The Illinois Central Railroad Company.

Prior to 1888 there was no general law relating to harbors under which the relative rights of the States, and of corporations and individuals claiming under the States or General Government, to the use of submerged lands by filling them up, and to riparian rights of accretion, dockage, and wharfage, and of the rights of the public generally, or the United States collectively, to the unobstructed and free navigation of the navigable waters of the United States, could be limited or defined. but in the river and harbor act of 1888 is contained the following provision, under which the Board of Engineers is assembled.

SEC. 12. Where it is made manifest to the Secretary of War that the establishment of harbor lines is essential to the preservation and protection of harbors, he may, and is hereby authorized to cause such lines to be established, beyond which no piers and wharves shall be extended or deposits made, except under such regulations as may be prescribed from time to time by him.

Whatever opinions and consequent actions may have heretofore been had as to the authority of the General Government, through its Executive Departments, in limiting riparian rights, or in directing and conditioning the application of these rights, the Board consider that by the establishment under the act of August 11, 1888, of a dock or harbor line "beyond which no piers or wharves shall be built or deposits made," the Secretary of War limits not only the riparian rights of individuals to wharfage or dockage, and the rights of the State to fill in or authorize the filling in of submerged lands, but limits, also, the rights of the public generally, or of the General Government, to the unobstructed rights of navigation, the limit being at this harbor line.

Under this view of the law the Board consider that they can recommend neither the approval nor the disapproval of any constructions under State, corporate, or individual authority between the established dock line and the shores of the lake within the harbor area. The Board is, however, of the opinion that any uses of this area by filling or other than by wharves and docks, as originally contemplated and still desirable, will diminish the possible value of the harbor for commercial purposes. It is further of the opinion that such contemplated uses of the submerged lands within the dock and shore lines will not affect practically the prospective use of this harbor, or the future fulfillment of the necessities of navigation at this port.

O. M. POE,
Colonel of Engineers.
CHAS. E. L. B. DAVIS,
Major of Engineers.
W. L. MARSHALL,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
September 19, 1890.

Respectfully submitted to the Secretary of War.

It having been made manifest to the Secretary of War that the establishment of harbor lines is essential to the preservation and protection of the harbor at Chicago, Ill., a Board of Engineers was constituted by Special Orders from Headquarters, Corps of Engineers, to consider and report upon the subject, and the Board recommends for approval of the Secretary of War the harbor and dock lines described in the within report and delineated upon the accompanying chart.

It is recommended that the line selected be approved and that the Secretary place his approval both upon the report and the drawing* submitted.

H. M. ADAMS,
Major, Corps of Engineers, in charge.

WAR DEPARTMENT,
September 22, 1890.

Approved.

L. A. GRANT,
Acting Secretary of War.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., September 20, 1890.

SIR: I have the honor to submit herewith the report, dated September 17, 1890, of the Board of Engineers constituted by Special Orders No. 61, Headquarters, Corps of Engineers, September 11, 1890, to con-

* Omitted.

sider and report upon the subject of harbor lines (pier and bulkhead) at Chicago, Ill.

The action of this Board has been had under the provisions of the act of August 11, 1888, authorizing the Secretary of War to establish a harbor line beyond which no deposits shall be made. Up to the passage of this act there was no statute authorizing the Secretary of War to fix such lines in our harbors, but several prior acts of the Secretary of War approving suggested lines had been respected in part by riparian owners. Such was the case in Chicago, two Boards of Engineers, of 1871 and 1882, having suggested lines covering portions of the harbor, which lines were approved by Secretaries Belknap and Lincoln. The line suggested in this report is substantially the line recommended by the Boards of 1871 and 1882 and heretofore approved, and in my judgment is correctly located. As to the use the riparian owners may make of the space inside the harbor line, the United States would not seem to have control unless such use would evidently obstruct or damage the general navigation of the port. I would, therefore, recommend that the harbor line as recommended by the Board of Engineers of September 11, 1890, be approved by the Secretary of War.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

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